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The Branner Geologica

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J C Stramm

AN

INDEX TO THE GEOLOGY

OF THE

NORTHERN STATES,

WITH TRANSVERSE SECTIONS,

EXTENDING FROM SUSQUEHANNA RIVER TO THE ATLANTIC,
CROSSING CATSKILL MOUNTAINS.

TO WHICH IS PREFIXED

A GEOLOGICAL GRAMMAR.

BY AMOS EATON, A. M.

LECTURER ON NATURAL HISTORY AND CHEMISTRY IN THE TROY
LYCEUM, PROFESSOR OF BOTANY IN CASTLETON MEDICAL
ACADEMY, MEMBER OF THE AMERICAN GEOLOGICAL
SOCIETY, AND CORRESPONDING MEMBER OF THE
NEW-YORK LYCEUM OF NATURAL HISTORY.

SECOND EDITION,

WHOLLY WRITTEN OVER ANEW, AND PUBLISHED UNDER
THE DIRECTION OF THE TROY LYCEUM.

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INDEXES to the great book of Nature."

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1820.

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Northern District of New-York, to wit:

L. S.

BE it Remembered, That on the tenth day of April, in the forty-fourth year of the Independence of the United States of America, A. D. 1820, WILLIAM S. PARKER, of the said District, hath deposited in this Office the title of a book, the right whereof he claims as proprietor, in the words following, to wit:

" Index to the Geology of the Northern States, with transverse
" sections, extending from Susquehanna river to the Atlantic,
" crossing Catskill mountains. To which is prefixed a Geologi-
" cal Grammar, by Amos Eaton, A. M. Lecturer on Natural
" History and Chemistry in the Troy Lyceum, Professor of Bot-
" any in Castleton Medical Academy, Member of the American
" Geological Society, and Corresponding Member of the New-
" York Lyceum of Natural History. Second Edition, wholly
" written over anew. " Systems of Natural History, however vo-
" luminous, are but Indexes to the great book of Nature."

In conformity to the act of the Congress of the United States, entitled " An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the times therein mentioned;" and also, to the act, entitled " An act, supplementary to an act, entitled ' An act for the encouragement of learning, by securing the copies of Maps, Charts, and Books, to the authors and proprietors of such copies, during the times therein mentioned,' and extending the benefits thereof to the arts of designing, engraving and etching historical and other prints."

RICH'D. R. LANSING,
Clerk of the Northern District of New-York.

WM. S. PARKER, PRINTER.

To George Gibbs, Esq.

FIRST VICE-PRESIDENT OF THE AMERICAN GEOLOGICAL SOCIETY, &c. &c.

I HAD been struggling for several [illegible]rs against difficulties almost insurmountable, in the pursuit of knowledge in the Mineralogical department of Natural Science, before I placed myself under the instruction of your learned and indefatigable friend, at your splendid cabinet in Yale College. Even then I felt myself lost as it were, at my first entrance, in a vast wilderness of science. But in the course of one year, that systematic order became manifest, which pervades your august assemblage of representatives from all the interesting mineral districts on our planet.

In this treatise I have endeavored to contribute " a mite" in aid of your grand scheme for facilitating the study of North American Minerals. If you think it is calculated to aid the student in this pursuit, I shall expect a due share of your patronage. But if you find, that I have misconceived the interests of the science, it will be your duty to interfere and save the Republic of Letters from the evils of being misled by " blind guides."

With a high sense of my obligations to you, in common with every American who regards the interests of science, I subscribe myself

Your devoted humble servant,

AMOS EATON.

Troy, New-York, May 3, 1820.

TROY LYCEUM.

MAY 1, 1820.

THE Committee appointed to examine the manuscript of the second edition of Mr. EATON's Index to the Geology of the Northern States, and to advise and direct respecting its publication, report:

That, in the opinion of the Committee, it contains a valuable record of geological facts, and a system of North American Geology supported by those facts. Thereupon it was

Resolved, That this Society do adopt Mr. EATON's Index to the Geology of the Northern States, as a system of North American Geology.

Resolved, That, as the most important materials embraced in it have come under the immediate observation of this Society and its members, it is recommended as AN AUTHENTIC RECORD OF GEOLOGICAL FACTS.

DAVID BUEL, JUN.
2d Vice-President.

CHAS. H. MERRITT,
Recording Secretary, pro. tem.

PREFACE.

THE first edition of this Treatise was intended for my pupils, as an Index to the localities where they were to look for specimens to illustrate this branch of Natural Science: not, however, without the expectation that it would fall into the hands of many others. It was then a matter of doubt, whether I was to expect severe criticism or total neglect. It now appears, that *learned* geologists were inclined to give me more credit, than I had a right to claim.* While some others, who derived their small stock of geological knowledge entirely from my labours, make a great display, without so much as noticing my little book or its author.

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* See American Journal of Science, North American Review, New-York Monthly Magazine, &c.

The first edition contained many errors. In truth the errors are so numerous, that I shall not attempt to point them out. But I shall treat the subject as I now understand it; without detaining the reader with any apologies for former mistakes. I am very willing it should be said, that, "as this was the first "attempt at a general arrangement of geological "strata in North America, much allowance should "be made." I should not, however, feel greatly mortified, if closet critics should object to my plain unvarnished "matter of fact" method; and even if the more able theorists should accuse me [illegible] placing too much confidence in my own observations and opinions. I now answer them all at once. Go to the localities to which my Index refers you, and let Nature herself decide our controversies.

With respect to the theoretical part, as far as I have given in to any theory, it is to that of Werner, with the improvements of Cuvier and Bakewell.* But I hope I have no where compelled fact to bend to *any* theory. I expect to be censured for rejecting so many of the strata, which are given by European geologists. My reply is a short one—*I do not*

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* It is much to be regretted, that Bakewell is not yet reprinted in America.

*insert them, because I cannot find them.** If future discoveries bring more strata to our knowledge, they will be adopted of course. It is certainly most advisable to begin with those only, which have been clearly ascertained; and calculate to increase our list, when we shall be authorized by facts.

As the arrangement adopted in this work is wholly founded upon my own observations, it will be proper to mention some of the leading localities by which I was governed. I have attentively examined most of the western towns in Massachusetts, and a large portion of the eastern; every county in Connecticut; and the southwestern part of Vermont. Also, all that portion of the state of New-York, which lies between the west bounds of Massachusetts and the Susquehanna river; embracing the whole extent of the Catskill mountains. Most of the counties of Saratoga, Schenectady, Rensselaer and Albany, I have repeatedly examined with very particular attention. The district of country, which I have attentively studied for the last four years, is about one hundred and fifty miles in breadth; through the southern part of which runs the 42d degree of north latitude, and it extends very nearly from the 71st to the 76th degree of west longitude. I have also taken a hasty survey of the southern part of the state of New-York. My journies on foot, while in search of geological facts, will now exceed two thousand miles; leaving out of the account all my excursions in the vicinity of Troy and Albany, and more than another thousand of carriage and water travelling.

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* M'Clure says: "Many names I do not use; because I never met with them."

Though I repose perhaps an unwarrantable degree of confidence in the arrangement of strata which I have adopted, more especially since it has been confirmed by the researches of so many members of the Troy Lyceum and others; yet I am prepared to adopt any amendments which future discoveries shall warrant.

It is not pretended that many principles absolutely new will be developed in this work. Nothing more is promised, than a faithful application, to North American Geology, of those principles which have been brought to light by the researches of the learned geologists of the old and new world. The President of the American Geological Society, William M'Clure, Esq. has already struck out the grand outline of North American geographical geology. The first Vice-President, Col. G. Gibbs, has collected more facts and amassed more geological and mineralogical specimens than any other individual of the age. The second Vice-President, Professor Silliman, his learned and indefatigable colleague in these labors, gives the true scientific dress to all the naked mineralogical subjects, which are furnished to his hand. The third Vice-President, Professor Cleaveland, is successfully employed in elucidating and familiarizing those interesting sciences; and thus smoothing the rugged paths of the student. Professor Mitchill has amassed a large store of materials, and annexed them to the labors of Cuvier and Jameson. But the drudgery of climbing cliffs and descending into fissures and caverns, and of traversing, in all directions, our most rugged mountainous districts, to ascertain the distinctive characters, number and order of our strata, has devolved on me. I make no pretensions to any peculiar qualifications, other than that bodily health and constitutional fitness for labor and fatigue, which such an employment requires.

The short courses of Geological Lectures, which I have given in the villages and towns situated in various parts of this district, have afforded me many advantages. More than one thousand of my pupils reside within its limits, many of whom have collected very interesting materials in aid of my purpose.

I have prefixed a concise grammar of geology for the benefit of students. This I have accommodated to my views of North American geology.

I consider nothing in geology entitled to much confidence, which is purely theoretical. But I am willing to be held as pledged for every fact given as such in this Index; unless there are cases (which I hope are few) where I misjudged respecting the name or character of a mineral or stratum.

Since the scientific world will no longer endure geological reveries and speculative dreams, it becomes necessary to cite the authority by which every position is supported. This renders a multitude of names of persons and places indispensable. I am sensible that a treatise defaced with so many proper names has a forbidding aspect; but without them it would appear to be a record of assertions rather than a record of facts.

A distinct treatise on the geology of our district is still wanted; and it is to be hoped that it may ere long appear. I mean a treatise on the local formations. Schoolcraft's View of the Lead Mines of Missouri is a sample of that kind of research, which should engage the attention of at least one experienced geologist in every state.*

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* I have lately received a letter from Dr. H. H. Hayden of Baltimore, by which I am happy to learn, that he has prepared a volume of essays on several geological subjects, which is soon to be published. This information must be highly gratifying to those who have heretofore been instructed by his labors.

DIRECTIONS FOR THE PLATES.

*** BOTH plates are to be put in as maps are set in an Atlas. They are of a size just sufficient to make two leaves equal to the leaves of the book, provided the slips of paper to which they are attached are so narrow as to bring the middle of the plates near the back.

Plate I, must follow this page. Plate II, must follow the Explanations on page 280.

Fig. 1

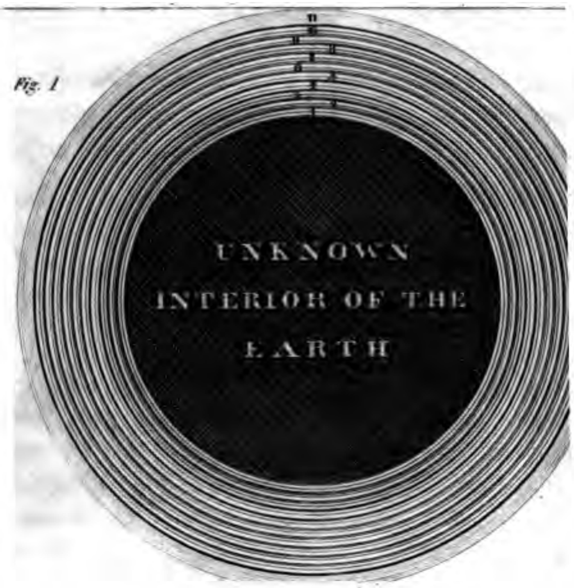

Fig. 3

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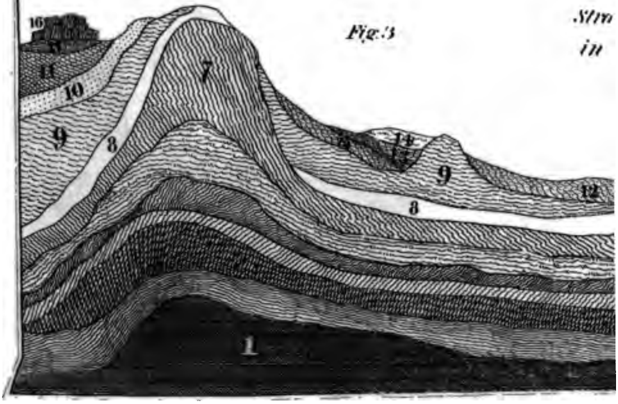
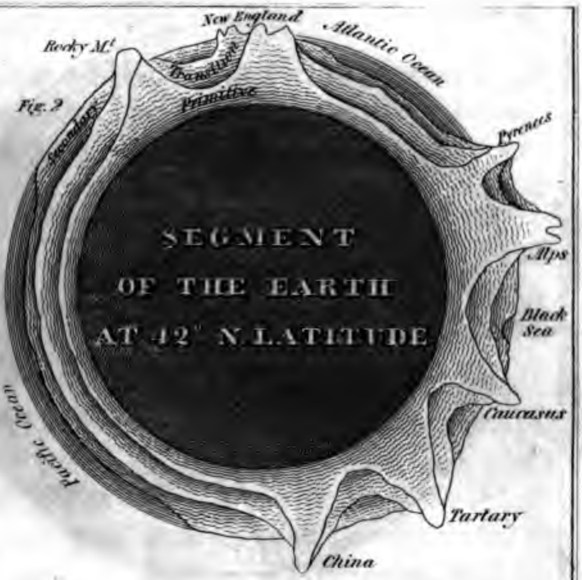


Fig. 2



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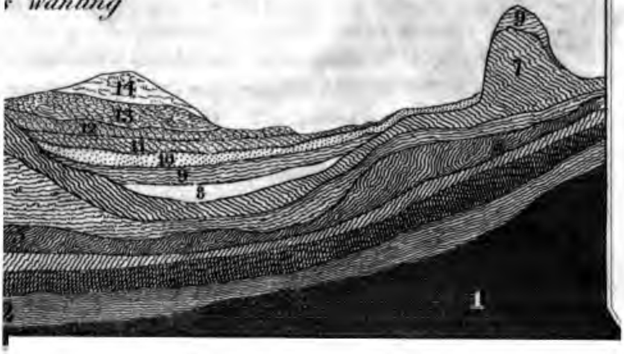

EXPLANATION OF PLATE I.

FOR the convenience of learners, I ſhall adopt the following theory.

That at the creation, the materials conſtituting the earth were finely comminuted and mixed with water, ſo as to form the chaotic paſte. That theſe materials united together by attraction of coheſion or aggregation, and ſettled down towards the center in layers arranged nearly in the order of their ſpecific gravities.*

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* It has been demonſtrated by Dr. Maſkaline and others, that what is below the granite all taken together is about five times as heavy as a globe of water of the ſame bulk, or has about double the ſpecific gravity of the granite and all above it. The proof of this fact is founded on the deviation of a plum-line from a true perpendicular, when ſuſpended by the ſide of an inſulated mountain of naked rock. The ſpecific gravity of the mountain may be aſcertained by actual trial of average ſpecimens from it. Its cubic feet may be found by meaſure; and the cubic feet contained in the earth may alſo be found by calculation. The deviation of the plum-line ſhould be as the cubic feet of the

Conſequently concentric hollow ſpheres were formed, encloſing each other like the coats of an onion. Theſe are repreſented by Fig. 1.

The Granite is denoted by No. 1, Gneiſs 2, Hornblende rock 3, Mica-ſlate 4, Talcoſe rock 5, Granular limeſtone 6, Argillite 7, Metalliferous limeſtone 8, Graywacke 9, Red ſandſtone 10, Muddy waters ſurrounding the earth 11. The four outer ſtrata called tranſition rocks, were formed after ſome marine animals were created; as ſuch animals are now contained in them, in a ſtate of petrifaction.

The outer rocks, denominated ſecondary, which ſometimes contain petrifactions of organized beings, which inhabited *dry land*, are of more recent formation and not repreſented in the figure. In a very early ſtate of the earth there were probably many local formations under water ſuch as Superincumbent rocks, Alluvials, &c.

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mountain to the cubic feet of the earth. But it turns out to be but half as much as it ſhould be, when the ſpecific gravity of the rock is two and a half. Therefore the earth is five.

That in due time ſome force (perhaps the expanſion of ſteam by the agency of the internal heat of the earth) was exerted beneath the granite, ſufficient to overcome the weight and ſtrength of the granite and of all the rocks outſide of it. That this force, extending around the earth between the granite and the unknown ſtratum next beneath it, at length burſt forth driving the granite through the outer ſtrata in ſeveral places, and thereby raiſing up their broken edges into a highly inclined poſition. By this proceſs iſlands, or even continents, of rocks, and perhaps ſupporting ſome ſubmarine ſoils, were raiſed out of the waters hitherto enveloping the earth.

That the uppermoſt of the elevated ſtrata, being moſt expoſed and of a ſoft texture, ſoon crumbled down and formed ſoils ſuitable for the production of vegetables and the habitation of animals. Theſe organized beings were frequently ſwept into the ſea and ſometimes intermixed with marine relics. From continued abraſions and diſintegration rocks above and below the waters were reduced to pebbles, ſand and paſte, from which new rocks were formed.

Theſe moſt recent rocks entombed both marine and land relics. After a further ſubſidence of the waters many of theſe rocks were left bare alſo; which are now called Secondary rocks.*

That the rents made by the grand exploſion, which firſt upturned and disfigured the rocky cruſt of the globe, were in a north and ſouth direction. That thoſe, croſſing the 42nd degree of north latitude, were principally made at the Pyrenees and Alps in Europe, Caucaſus, Tartary and China in Aſia, Rocky Mountain and New-England in America. They are repreſented in Fig. 2.

The north and ſouth rents now conſtitute the central lines of the leading ranges of primitive rocks, from which the ſeries of rock ſtrata are reckoned. Other more limited exploſions, called volcanoes, have frequently occured; which, with inundations and other cauſes, gave riſe to many local formations.

Figure 3. repreſents a ſection of ſecondary country, where all the old and new ſtrata are ſuppoſed to be preſent.

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* Have petrifactions of *dry-land* animals or plants been found in rock ſtrata highly elevated?

Whether this theory accords with the real origin of the preſent ſtate of things or not, is immaterial. It is introduced ſolely for the purpoſe of aiding the memory in ſtudying the ſtrata, which we know do exiſt. It is preferred for this uſe; becauſe it is more ſimple and ſeems to accord with more phenomena, than any theory hitherto ſuggeſted.

GRAMMAR

OF

GEOLOGY.

ALPHABET.

THOSE, who are unacquainted with Mineralogy, can make no progreſs in Geology, without a familiar acquaintance with nine homogeneous minerals. Every ſtratum conſiſts of one or more of theſe nine minerals; therefore they are aptly denominated the Geological Alphabet. They are, 1. Quartz, 2. Felſpar, 3. Mica, 4. Talc, 5. Hornblende, 6. Argillite, 7. Limeſtone, 8. Gypſum, 9. Chlorite.

I. Quartz. When held between the eye and a window, it reflects light ſomewhat like a poliſhed piece of cold tallow. This [illegible] called its luſtre. On attempting to ſcratch it with a penknife, the metal will leave a trace on it, and it will not be ſcratched. It is commonly glaſs-colour, but it is often milk-white, reddiſh, and of various other colours. Quartz conſiſts of about 93 per cent ſilex, 6 alumine or clay, 1 lime, beſides 2 or 3 per cent of water in a ſolid ſtate.

II. Felspar, or Feldspar. Its luſtre is peculiar; but it in ſome meaſure reſembles that of a broken edge of china ware. It may be ſcratched with a knife. Its colour is generally white or fleſh-coloured. It is beſt aſcertained when in the ſtate of a rock aggregate by procuring an outſide fragment, which had been long expoſed to air and moiſture. In this ſtate it always aſſumes a peculiar tarniſh, of a yellowiſh hue. Felſpar conſiſts of about 63 per cent ſilex, 17 alumine, 13 potaſh, 3 lime, 1 iron, 3 water.

III. Mica. It is always in ſhining laminae or ſcales. It is every where known by the improper name of iſinglaſs. The ſcales are always elaſtic. It conſiſts of 48 per cent ſilex, 34 alumine, 9 potaſh, 5 iron, 1 manganeſe, 3 water. Black mica contains 22 per cent iron.

IV. TALC. It often reſembles mica; but can readily be diſtinguiſhed from it by being non-elaſtic. Take a ſmall ſcale or fibre of it in a pair of tweezers, put it under a magnifier and bend it with the point of a fine needle. If it remains as it is bent, it is talc; if it ſprings back it is mica. It always gives a rock the unctuous or ſoapy feel. It conſiſts of 62 per cent ſilex, 27 magneſia, 2 alumine, 3 iron, 6 water.

V. HORNBLENDE. It is the tougheſt of all earthy minerals. Generally it preſents a kind of confuſed fibrous ſtructure. It may be ſcratched with the knife. The colour is always greeniſh, browniſh or black. Sometimes it appears in black ſcales, reſembling black mica to the naked eye. But under the magnifier it differs materially. It conſiſts of about 42 per cent ſilex, 12 alumine, 11 lime, 3 magneſia, 30 iron, 1 manganeſe, 1 water.

VI. ARGILLITE. This needs no deſcription. The common roof-ſlate and the ſlate uſed for cyphering in ſchools are good ſpecimens. It conſiſts of about 38 per cent ſilex, 26 alumine, 8 magneſia, 4 lime, 14 iron, 10 of potaſh, ſoda, manganeſe, water, &c.

VII. LIMESTONE. Common marble affords good ſpecimens. It ſhould be teſted by a drop of muriatic, nitric or ſulphuric acid, which will cauſe an effervefcence or bubbling. It conſiſts of 57 per cent of lime, 43 of carbonic acid. Sometimes it is coloured with iron and often contains a little ſilex and alumine.

VIII. GYPSUM. Common plaiſter of Paris. It will not effervefce with acids and is generally ſofter than limeſtone. It conſiſts of 32 per cent lime, 46 ſulphuric acid, 22 water.

IX. CHLORITE. It is a little harder than talc, but may be ſcratched with the finger nail. Under the magnifier it appears like a compact maſs of fine green ſcales. When breathed on it gives an odour in ſome meaſure reſembling clay. Its elementary conſtituents are variable. They will average about 40 per cent ſilex, 23 alumine, 18 magneſia, 15 oxid of iron, 2 lime, 2 water. This is the leaſt important of the whole nine.

After ſtudents can readily recognize theſe nine minerals, they ſhould be exerciſed in pointing them out in their various ſtates of aggregation. They will ſoon be enabled to ſpell out any rock with facility.

CLASSES.

THE exterior rind of the earth is divided into five claſſes.

CLASS I.

PRIMITIVE ROCKS.

Theſe are the ſix kinds, which, while they remain in their original poſitions undiſturbed, are the loweſt with which we are acquainted. They are diſtinguiſhed from all the rocks of the other claſſes by their being always deſtitute of organic relics, or the petrified remains of animals and vegetables. They appear to have been originally formed in horizontal ſtrata; and afterwards to have been forced upwards, in ſome parts of the earth, by a power exerted beneath them, reſembling in its effects the expanſion of ſteam by heat. Theſe ſtrata, when thus forced up, moſtly approach a vertical poſition. In North America this claſs of rocks appears in North and South ranges.

CLASS II.

TRANSITION ROCKS.

These are the four kinds, which reſt immediately upon the primitive claſs, or incline againſt its ſides. They are diſtinguiſhed from the rocks of the primitive claſs by their containing organic relics. And they are diſtinguiſhed from the ſecondary claſs by their containing no petrifactions but thoſe of marine origin.

CLASS III.

SECONDARY ROCKS.

These are the four kinds, which are the uppermoſt in the ſeries of regular rock ſtrata. They are diſtinguiſhed from the two preceding claſſes by their containing, not only marine petrifactions, but thoſe alſo which are of dry-land and freſh-water origin, It is probable that future diſcoveries will compel us to add another claſs, to embrace LOCAL FORMATIONS.

CLASS IV.

SUPERINCUMBENT ROCKS.

Theſe rocks overlay others in a non-conformable poſition. In our diſtrict they generally reſt upon breccia or red ſandſtone; and are always above primitive hornblende rocks, They are moſtly granular aggregates in which one eſſential conſtituent is hornblende. When wet they exhibit a greeniſh hue. A columnar, polyhedral, or rhomboidal tendency is always manifeſt. Bakewell and many others conſider them of volcanic origin.*

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* Bakewell is inclined to believe, that Sienite is of volcanic origin alſo. But the poſition of every variety of ſienite in our diſtrict gives the higheſt evidence, that it is excluſively a primitive rock. From the poſition of the greenſtone trap at Deerfield and Northampton, Maſs. it would not require a great effort of fancy to conceive it to have been formed of melted primitive hornblende rock; as this ſtratum undoubtedly paſſes beneath it, and we have no evidence that a communication between them is not made by a rent through the interpoſed ſtrata.

CLASS V.

ALLUVIAL FORMATIONS.

Theſe are the various looſe layers, which are formed of diſintegrated or broken rocks. Sometimes theſe broken fragments, even though pulverized, are cemented together, forming puddingſtone, calcareous breccia, indurated marl, &c. But this formation conſiſts chiefly of gravel, ſand, clay and loam. The indurated maſſes may be denominated alluvial rocks.

VOLCANIC PRODUCTIONS.

Theſe do not form a diſtinct claſs of geological ſtrata; though perhaps they may belong to the ſuperincumbent claſs. Any minerals, upon which changes have been wrought by volcanic fires, belong here.

The moſt common kinds of volcanic productions are: **Lava**, which ſeems to be compoſed chiefly of melted hornblende ſlowly cooled—**Obsidian**, which is the ſame as lava cooled ſuddenly—PUMICE, which is ſaid to be formed chiefly of melted felſpar—TUFA or VOLCANIC BRECCIA, which is an aggregated maſs of volcanic ſtones, cemented together by volcanic aſhes.

REMARK.

Although the arrangement adopted in this Grammar correſponds with the order of ſtrata, viewed on a large ſcale; yet much confuſion often obtains in limited localities. A good example may be found in the avenue to the Southampton lead mines, Maſs. See the American Journal of Sciene, page 136. Here the general ſtrata are only Granite, Mica-ſlate, Talcoſe rock and Alluvion including coal between layers of micaceous ſandſtone, &c. though an aggregate reſembling Graywacke, alſo ſerpentine and Mica-ſlate, alternate with the Granite.

Another very important locality is to be found in the weſt part of Maſſachuſetts. Near the ſouth bounds of the ſtate there appears to be but one range of granular limeſtone, and that in its true place, as located in the ſyſtem of arrangement. But on purſuing this ſtratum a very little diſtance to the north, it divides into two extenſive ranges, continuing far into the ſtate of Vermont. And ſoutherly it divides into three ranges, which in ſome places diverge from each other to the diſtance of ſeveral miles. A little ſouth of Williams College, the ranges of this ſtratum are ſeparated by a mountain of gneiſs, mica-ſlate, talcoſe rock, and granular quartz, 24 hundred feet in height. Though in this locality there appears to be great confuſion in the order of ſtrata; if our examinations are ſufficiently extended, uniformity in the arrangement of analogous rocks becomes manifeſt.

STRATA.

EACH claſs is ſubdivided into ſtrata.

I. PRIMITIVE CLASS.

1. *GRANITE.*[*]

IT conſiſts of quartz, felſpar and mica, aggregated irregularly; preſenting a granular, not a ſlaty appearance. It may be coarſely or finely granulated. The oldeſt rocks are generally the coarſeſt. When the felſpar is white, it is called grey granite; when fleſh-coloured, red granite; when blue, which is rare, blue granite. It often forms veins, traverſing gneiſs

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[*] Any rock ſtratum may contain many other minerals beſides thoſe, which are eſſential. Theſe are to be conſidered as accidental and are not to be taken into view in determining the character of a rock. For example, if ſhorl or beryl be found in granite, the rock is granite, notwithſtanding.

4. *MICA-SLATE.*[*]

It is eſſentially compoſed of mica and fine-grained quartz. It is of a ſlaty ſtructure and eaſily broken or ſplit. When the hornblende rock is not interpoſed, it paſſes into gneiſs. Some varieties of it can hardly be diſtinguiſhed from the ſofteſt varieties of gneiſs.

5. *TALCOSE ROCK.*[†]

It conſiſts eſſentially of talc and quartz very finely comminuted. It paſſes into mica-ſlate. The meeting and mixing of theſe two ſtrata produce the common ſcythe whetſtone,[‡] and one variety of the ſand uſed in glaſs factories.[§]

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[*] Called alſo Micaceous ſchistus. In the Northern States this is not generally a very extenſive ſtratum.

[†] I adopt this name by the advice of Profeſſor Silliman, as a ſubſtitute for ſteatite or ſoapſtone. He has the authority of Profeſſor Strouve, in ſuport of his own opinion.

[‡] As near the northeaſtern part of Belchertown, Maſs. and in Smithfield, R. I.

[§] As in Berkſhire county near Lenox, Maſs.

The micaceous iron ore is alſo formed at this meeting of ſtrata.*

6. *GRANULAR LIMESTONE.*

It conſiſts eſſentially of glimmering grains of limeſtone. Sometimes a large proportion of the rock conſiſts of grains of quartz forming a kind of calcareous ſandſtone. It is generally aſſociated, or alternates, with large beds of granular quartz; even mountain maſſes.† It frequently alternates with ſeveral of the preceding ſtrata.‡ Sometimes it contains Serpentine.§ Sometimes it paſſes into Dolomite.‖

* As in Hawley, Maſs.

† As thoſe near Williams College, Maſs.

‡ See Remark, Page 29.

§ As the Milford quarry, Con.

‖ As in Canaan, Con.

II. TRANSITION CLASS.

7. *ARGILLITE.**

It is homogeneous in its appearance; being the ſame as the ſixth mineral deſcribed in the geological alphabet. Like the ſlate of Charnwood foreſt, England, mentioned by Bakewell, the ſlaty laminae in our diſtrict generally make a large angle with the planes of the ſeams ſeparating the layers. Sometimes they are nearly vertical and curvilinear. Moſt of the layers are of vaſt thickneſs. It paſſes into ſiliceous or flinty ſlate; and is often traverſed by veins of white quartz. It frequently embraces large ANOMALOUS aggregates. Near Troy and Albany it is often varniſhed with carburet of iron. It contains petrifactions of *orthocerites*, *pectenites* and *anomites*; but they are not frequently found.

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* The ſhining argillite, or proper primitive ſlate, is an imbedded, or ſubordinate, rock, found only with primitive rocks. The Preſident of the Troy Lyceum found it with granite in Vermont. I found in Schoharie county a very ſoft variety of argillaceous rock in an extenſive bed containing fibrous ſulphate of barytes, It ſeems to be a ſoft variety of gravwacke, under, and in immediate connexion with, compact limeſtone. Neither of theſe varieties can be miſtaken for the ſtratum here intended: and they have no connexion with it.

8. *METALLIFEROUS LIMESTONE.*[*]

It is more compact than primitive limeſtone; but under the magnifier it ſeems to be eſſentially compoſed of very minute glimmering grains. It is generally harder and lighter coloured than the compact limeſtone and contains very few petrifactions. Sometimes it is highly variegated in its colours. It ſometimes alternates with the ſtrata above and below its place. In South

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[*] Called Tranſition limeſtone alſo. The exiſtence of this ſtratum along the eaſt ſide of Lake Champlain in Vermont, ſeems to be demonſtrated by that very accurate naturaliſt, Dr. Edwin James. We have reaſon to ſuſpect, that it alternates with argillaceous ſlate in Renſſelaer and Columbia counties; but this ſubject has not been ſufficienly inveſtigated. I have a ſpecimen from Potoſi in South America. containing ſilver ore, which is ſofter and more variegated in colour, than the ſpecimens from Vermont. See Dr. James' eſſay in a note further on.

America, and in moſt other countries it abounds in ores.

9. *GRAYWACKE.*

It conſiſts eſſentially of grains of quartz cemented together by indurated clay. It is almoſt always of a dull grey colour, rarely a little greeniſh.* It may be diſtinguiſhed from every variety of ſandſtone by magnifying its conſtituent particles. For the magnifier ſhews the empty interſtices between the quartzoſe particles of all ſandſtones, which are chiefly filled up with alumine in graywacke. Graywacke will always crack and become fiſſile by heating, on account of the aluminous cement. Whereas ſandſtone will merely crumble to pieces, or become pulverized by heat.

There are two varieties of graywacke, which ſeem to paſs into each other. They are denominated *rubbleſtone* and *graywacke-ſlate.* The former is harder, coarſer and rarely contains any glimmering ſcales. Its conſtituents are from the ſize of a pin-head to ſeveral inches in extent. Large pieces of ſlate are often embraced in it.* The ſlaty variety is the moſt extenſive. It always, I believe, exhibits glimmering ſcales of talc or mica. It is the moſt variable of all rocks, and contains the moſt imbedded maſſes. It paſſes into a ſoft fine-grained variety, which is generally miſtaken for argillaceous ſlate; but may be diſtinguiſhed by the glimmering ſcales. This ſoft variety forms the beſt fine-grit grindſtones and hones.† It is ſometimes very irregularly fiſſile, ſo that it cannot be quarried.‡ Sometimes it is ſo compact that it takes a very good poliſh.§ It often embraces vaſt beds of coarſe ſandſtone or gritſtone.|| It abounds in ores in many places.¶ In our diſtrict it is the baſis rock of more than ten thouſand ſquare

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* As that weſt of Milford quarry in Connecticut.

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* The moſt perfect ſpecimens of this variety are thoſe, which are quarried at the ſouth end of the bridge on Norman's Kill, two miles below Albany.

† As at Van Vechten's mill and Eaton's mill, Catskill, and at Patchen's mill in Blenheim, N. York.

‡ As in the eaſt face of Catſkill mountain, N. York.

§ As in Buel's quarry near Troy, N. York.

|| As in Blenheim, N. York.

¶ The lead ore in Livingſton's Manor is in this ſtratum.

miles.* It contains *anomites*, *pectenites*, *orthocerites*, *terebratulites*, *chamites*, *myites*, &c.

10. *RED SANDSTONE.*

It conſiſts eſſentially of grains of quartz aggregated together, or perhaps cemented together by alumine and red oxyd of iron; but the interſtices between the grains are not filled as in graywacke, but are more or leſs empty. It is red or reddiſh grey, ſometimes paſſing into a grey coarſe gritſtone.† It contains petrifactions of the *corallinites* in very great abundance.‡ It

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[*] The members of the Troy Lyceum have taken great pains to obtain correct information reſpecting this ſtratum. It appears that European geologiſts have made ſeveral ſtrata from it. But its great extent in our diſtrict, embracing the whole of Catskill mountain with all its vaſt weſtern ſpurs, enables us to examine the relative poſitions of all its varieties on a large ſcale.

[†] As at the ſouth end of Mount Tom, Northampton, Maſs.

[‡] According to the definition of the claſſes, this ſtratum muſt go into the Secondary claſs, if its petrifactions are not of marine origin. Jameson ſays "on a general view, it might be viewed as the neweſt member of the tranſition claſs." He leaves it in the Secondary however. This he ought to do, if he is correct in conſidering theſe petrifactions as the "trunks or branches of trees," which they certainly reſemble. I fell into the ſame error in the firſt edition of the Index. I think ſome of the ſpecimens in

alternates with the upper layers of graywacke. This is the common red freeſtone.

the Troy Lyceum clearly demonſtrate theſe relics to be of marine origin. Though they do not contain a particle of carbonate of lime, which we ſhould expect generally to find in moſt ſpecies of Martin's genus Eriſmatolite; yet ſome ſpecies of his ſection *Corallinarum* appear to have been originally corneous. And even the whole ſpecies Corallinite may not have been calcareous.

Bakewell places it here; and M'Clure ſays he ſhould incline to the ſame arrangement. Therefore on this authority, the ſuggeſtion of Jameſon, its alternating with graywacke, and embracing marine relics only, I have concluded to place it in this claſs.

III. SECONDARY CLASS.

11. *BRECCIA.*[*]

It conſiſts of coarſe grains of various rocks aggregated or cemented together, moſtly by alumine, and red oxyd of iron. Some of the grains are always rounded. They are from the ſize of a pin-head to that of ſeveral feet in extent. It always reſts upon red ſandſtone in our diſtrict.

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[*] This ſtratum is ſometimes omitted by geologiſts. But it is ſuch an univerſal aſſociate with red ſandſtone in our diſtrict, that it cannot be omitted. As it is manifeſtly of more recent formation than the ſandſtone, it will introduce confuſion in the ſyſtem to treat it as a ſubordinate rock. No two rocks are more diſtinctly marked by invariable characteriſtics than theſe. The ſandſtone is entirely made up of angular grains moſtly of the ſame kind; breccia moſtly of rounded ones, of very different kinds. There is ſome difficulty in diſtinguiſhing hand ſpecimens from Puddingſtone. But as the latter is an alluvial rock, or a mere maſs of cemented gravel, there can be no difficulty, when examined in place. Some of the moſt deciſive localities are thoſe of Catſkill mountains, Deerfield and Northampton, Maſs. Middletown, Con. Calcareous and Silicious breccia have no connexion with this ſtratum. They are ſubordinate to other rocks. Alſo the quartzoſe breccia uſed for millſtones.

12. *COMPACT LIMESTONE.**

It conſiſts chiefly of carbonate of lime, which is not made up of glimmering grains, but has a more dull earthy appearance. Particles of conſiderable luſtre are often interſperſed throughout large maſſes of it; but theſe are imperfect cryſtals, very different from the glimmering grains of granular limeſtone. Sometimes it is traverſed by veins of very perfect cryſtals; ſometimes it contains maſſes of imperfect cryſtals, called calcareous ſpar. It is rarely, if ever, pure; but generally contains conſiderable alumine or ſilex. Iſaac M'Conihe, Eſq. preſented ſpecimens of the white Lithographic ſtone to the Troy Lyceum, which he found alternating with this ſtratum in Indiana. In our diſtrict it ſeems to be chiefly made up of ſemi-diſintegrated ſhells, held together by a cement compoſed of the diſintegrated parts. Its colour is generally blue or brown.

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* It is called Shell limeſtone, and Floetz limeſtone. It reſts upon graywacke, when the red ſandſtone and breccia are wanting; as in the Heldeberg, ſouthweſt from Albany. Jameſon makes ſeveral ſtrata of this; and among them interpoſes variegated ſandſtone, bituminous ſhale and coal. Perhaps theſe may be diſtinguiſhed in our diſtrict. Until they are, we may conſider them as ſubordinate to this ſtratum.

13. *GYPSUM.*

It is homogeneous, being the ſame as the eighth mineral deſcribed in the Geological Alphabet. In our diſtrict it is frequently combined with carbonate of lime; and is often dark coloured, and even black. Salt ſprings are frequently found in the vicinity of this ſtratum; which has induced many to believe that a ſtratum of rock ſalt was once in connexion with it in the weſtern part of the ſtate of N. York, &c.*

14. *SECONDARY SANDSTONE.*

It conſiſts of quartzoſe particles ſimply aggregated together, or mixed with grains of limeſtone or with clay. It is very various in colour and texture, from coarſe gritſtone to the fine-grained and almoſt compact.* *Phytolites* and other organic relics are found in this ſtratum.†

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* Since the ſame range of gypſum extends into the regions of the Miſſiſippi, according to M'Clure, where rock ſalt is ſtill found; have we not good reaſon to believe that theſe two ſtrata exiſt in connexion, or in the vicinity of each other, wherever ſalt ſprings abound? It is undoubtedly the moſt rational conjecture, that the ſalt ſprings are ſupplied by the continued ſolution of rock ſalt, which lies beneath the alluvial depoſites.

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* I am not ſo well acquainted with this ſtratum, as I ought to be. It is probable that it might be divided into the Silicious, Argillaceous and Calcareous ſandſtone, in conformity with the diviſions made by European geologiſts. But it may be placed under this general head, until it has been extenſively examined. Myron Holley, Eſq. a Canal Commiſſioner, informed me, that ſeveral varieties of this ſtratum frequently occurred along the courſe of the great Weſtern Canal. The calcareous variety makes an excellent cement for the locks, which hardens under water. Specimens have been preſented to the Troy Lyceum, confirming Mr. Holley's ſtatement, which were collected in Indiana.

† On the Heldeberg, in the town of Bern, N. York, I found many petrifactions of a culmiferous plant in the Silicious variety of this ſtratum. Theſe are moſt abundant in and near a place called Pucker-ſtreet.

IV. SUPERINCUMBENT CLASS.

15. *BASALT.*[*]

IT conſiſts eſſentially of particles of hornblende, quartz and perhaps felſpar, ſo extremely minute and ſo intimately comminuted, that it appears to be homogeneous. It generally reſts upon breccia or red ſandſtone, and is beneath greenſtone trap. In our diſtrict it is generally of the amygdaloid variety—that is, forming cavities reſembling worm-holes in logs, which are either empty or filled with carbonate of lime, zeolite, &c. The moſt deciſive localities are at Deerfield and Northampton, Maſs.

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[*] It has been ſaid that we have no baſalt in our diſtrict. But Bakewell conſiders the greenſtone trap as a variety of baſalt. I have carefully compared ſpecimens of baſalt from Scotland and from Giant's Cauſeway in Ireland, with thoſe of Mount Holyoke near Northampton and of Deerfield, and I can diſcover no eſſential difference.

16. *GREENSTONE TRAP.*

It conſiſts of grains of hornblende, felſpar and generally quartz, aggregated together; but never too fine to be diſtinguiſhable by the eye. It generally exhibits a columnar polyhedral tendency. The moſt deciſive localities are at Deerfield and Northampton, Maſs. at New-Haven, Con. and on Hudſon river above N. York city.

V. ALLUVIAL CLASS.

17. *GEEST.**

It is that alluvial matter or ſoil, which ſeems to have ever remained near the place where it was firſt formed. It conſtitutes the earthy part of ſoils on hills or low lands, which is not generally very deep and was not derived from being waſhed down from the place of its original diſintegration. As this kind of alluvial is generally formed at or near the place of its depoſite; it conſiſts moſtly of the broken and pulverized fragments of the preſent exiſting rocks, or of thoſe which have recently paſſed away. From an examination of it under the magnifier we may determine with conſiderable accuracy, what rock has recently decayed in that particular ſpot. From an acquaintance with the exiſting rocks and by taking into view their homogeneous conſtituents, we may, on the other hand, judge of the ſoil which is now forming.

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* This term is uſed by De Luc and defined by Jameſon at the 192d page of the New-York Edition of Cuvier's Theory of the Earth.

18. *ALLUVION.*

It is that alluvial depoſite, which has been waſhed down from places where it was originally formed. It is often very deep, and is ſometimes tranſported from a great diſtance. Conſequently it is ſometimes very difficult to trace it back to the rocks from which it was derived.* It being derived from various ſources, and formed of various materials; theſe materials on meeting in a ſtate of ſolution or ſuſpenſion in water, often form new indurated compounds. Such as buhrſtone,* flint, indurated marl, puddingſtone, &c. and ſeveral Anomalous aggregates. Theſe latter may be called alluvial rocks, and each may be denominated according to its conſtituent elements.

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* The Hon. Samuel Young, Eſq. one of the Canal Commiſſioners, ſuggeſted to me (while I was giving a courſe of Agricultural lectures to the members of the legiſlature) that the barren ſand-planes weſt of Albany might be traced to their origin. He obſerved, that he had frequently been forcibly impreſſed with what appeared to be the very track of this vaſt body of alluvial ſand, as it moved down from that extenſive range of gneiſs rock, which commences in Saratoga county, and extends weſterly. On collecting ſmall quantities from various parts of theſe barren ſands, we found the quartzoſe particles to be of that tranſlucent hyaline variety, forming a conſtituent of primitive rocks. Scales of mica were alſo preſent, though in but ſmall quantities. It is probable that the alluvial iſlands at the mouths of great rivers might generally be traced back to their origin by attentively ſtudying their conſtituent particles, and comparing them with ſpecimens of various rock ſtrata mechanically pulveriſed.

Blocks and boulders are often found among alluvial depoſites, as well as lying looſe upon bare rocks far out of place, which were neither waſhed there, nor formed like alluvial rocks. Some geologiſts account for their removals by ſuppoſing them to have been tranſported by floating ice; others by imagining them to have been thrown up and ſcattered abroad by that power which burſt forth beneath the granite, and forced up the primitive rocks through the upper ſtrata.

The pebbles or gravel-ſtones in alluvion are always more or leſs rounded. Their rounded forms are to be aſcribed to two cauſes—to rolling againſt each other by the action of water; and to there being more ſurface expoſed to the disintegrating agents* at the angles than at the ſides, in proportion to the quantity of matter.

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* Mr. Schoolcraft and Mr. M'Conihe found buhrſtone in Miſſouri

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* Theſe agents, water, air and change of temperature, when operating upon angular fragments, diſſolve or crumble off theſe points with conſiderable rapidity. So that they will, in time, become rounded; if never rolled nor moved.

GEOLOGICAL SITUATIONS

OF THE USEFUL

MINERAL SUBSTANCES.

1. *QUARRY STONES.*

Marble Limestone for quicklime.	Granular and Compact limeſtone.
Primitive building-stone.	Fine-grained granite. Slaty gneiſs. Slaty hornblende rock. Soapſtone, talcoſe rock. Serpentine.
Transition building-stone.	Argillaceous ſlate. Graywacke ſlate. Imbedded ſandſtone. Red ſandſtone.
Plaister of Paris Alabaster.	Gypſum.

2. *COMBUSTIBLES.*

COAL. Above the poſition of Red ſandſtone, generally covered with bituminous ſhale or micaceous ſandſtone. It is frequently near Compact limeſtone.

PEAT. In alluvial, where vegetable ſubſtances are decompoſed and mixed with earthy matter, bitumen, &c.

BITUMEN. Waſhes out of alluvial formations and forms a pellicle of the petrolium variety on the ſurface of ſtanding waters. It is uſually called mineral oil.

SULPHUR. It is moſtly obtained from ſulphuret of iron, which abounds in argillaceous ſlate, graywacke and ſome other rocks.

3. *PRECIOUS STONES.*

TOPAZ. In Granite and Gneiſs.

EMERALD. In Granite.

RUBELLITE. In Granite.

SAPPHIRE
CORUNDUM
EMERY
RUBY.
} Probably all originally in Granite and Gneiſs; but they are generally found in alluvion.

CHALCEDONY
CORNELIAN
SARDONIX
AGATE
JASPER AGATE.
} In Superincumbent rocks and Alluvion.

JASPER. In Argillaceous ſlate, Limeſtone and Graywacke.

GARNET. In Granite, Gneiſs, Hornblende rock, Mica-ſlate, rarely in red ſandſtone and limeſtone.

QUARTZ CRYSTALS. In all rocks; perhaps the moſt perfect in Argillite.

DIAMOND. In Alluvion. Note.—Though it is placed among precious ſtones it is pure carbon; of courſe combuſtible.

4. *METALS.*

GOLD. Moſtly in veins of quartz in Granite Gneiſs and Hornblende rock. Sometimes in Metalliferous limeſtone and Graywacke. It is found in ſand of brooks in North Carolina; which ſand is probably from gneiss rock.

PLATINA. In ſands of rivers. As it is accompanied by magnetic iron ſand, it is probably from Granite or Gneiſs.

SILVER. Moſt in Metalliferous limeſtone. Alſo in Granite and Graywacke with lead.

MERCURY. In Argillaceous ſlate, Compact limeſtone with beds of bituminous ſhale, and in Alluvial clay.

COPPER. In Granite, Gneiſs, Hornblende rock, Argillaceous ſlate, Metalliferous limeſtone, Red ſandſtone and Superincumbent rocks.

Iron. In all ſtrata. Moſt at the Meeting of Mica-ſlate and Talcoſe rock. Magnetic ore in Granite and Gneiſs. Argillaceous and hematitic ore in compact limeſtone and alluvion. Pyrites is in all rocks, but moſt in argillaceous ſlate and graywacke.

Lead. In Granite, Gneiſs, Graywacke, Metalliferous limeſtone* and rarely in Compact limeſtone.

Tin. In Granite and Gneiſs.

Zinc. In Granite, Gneiſs and Compact limeſtone.

Nickel. In Hornblende rocks and Meteoric ſtones.

Cobalt. In Hornblende rocks and Compact limeſtone.

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* See Schoolcroft's view of the Lead mines of Miſſouri.

MANGANESE. In Gneiſs, rarely in Compact limeſtone.

ARSENIC. In Gneiſs, Hornblende rock, rarely in Compact limeſtone.

BISMUTH. In Granite, Gneiſs and Hornblende rock.

ANTIMONY. In granite, Gneiſs, Hornblende rock and Graywacke.

MOLYBDENA. In Granite and Gneiſs.

TITANIUM. In Granite, Gneiſs and Hornblende rock.

TUNGSTEN. In Granite, Gneiſs and Hornblende rock.

URANIUM. In Granite.

CHROME. In Talcoſe rock and Granular limeſtone, connected with imbedded ſerpentine. It is in the ſtate of an acid combined with an iron baſe.

ALLUVIAL DEPOSITES,

AS APPLIED TO

AGRICULTURE.

The earthy part of ſoils being formed of broken and pulverized rocks, it depends entirely on the conſtituents of the rocks out of which it is formed. Therefore the ſtudy of rocks is eſſential to the ſtudy of ſoils.

But as various ſalts, as well as other materials, reſulting from animal and vegetable decompoſitions, are intermixed with earthy ſoils, they become conſiderably complicated.

Soils may be very naturally divided into three parts. The gravelly and ſandy part, the argillaceous part, and the ſoluble part.

1. The GRAVELLY and SANDY part holds no more water, than merely what adheres to the ſurface of the particles. It neither takes up, nor gives off, water with great rapidity. If the gravel be pretty coarſe; when moiſtened, it retains a moderate portion of moiſture for a long time. Forming a looſe porous ſoil, roots of vegetables are not compreſſed in it. But where this kind of ſoil is in exceſs, it is too looſe to ſerve as a fit medium for tranſfuſing the proper nutriment into the roots of vegetables.

2. The ARGILLACEOUS part abſorbs a large quantity of water, with which it becomes combined throughout the maſs. In wet weather it is much wetter and in dry weather much drier, than gravelly ſoil. Conſequently roots of plants are ſurrounded with ſoft paſte at one time, and compreſſed with a dry indurated maſs at another. It follows that a due mixture of theſe two kinds of ſoil is very important to vegetation.

3. The SOLUBLE part conſiſts of whatever may be diſſolved or ſuſpended for ſome time in water, at the common temperature. Moſt of theſe ſubſtances are nutrimentous, and are par-

tially taken up and devoured by vegetables. Theſe are ſalts, as muriate of lime, muriate of ſoda, &c. carbonaceous matter, ſuch as proceeds from decompoſing culms and other parts of vegetables, as well as of animal matter, &c. This part of ſoils is tranſitory and requires to be frequently renewed.

In analyzing ſoils for practical uſe, theſe three kinds ſhould be ſeparated from each other, and carefully weighed. The agriculturaliſt will then be enabled to aſcertain the deficiencies in either part, and will of courſe be enabled to judge reſpecting the application of a remedy. He muſt, however, take into view the quantity of moiſture furniſhed by the ſituation of particular fields. A portion of ſoil ſhould be ſelected from various parts of a field and from various depths; then duly mixed, ſo as to give an average ſpecimen. This ſhould be dried as much as it can be, without burning ſome dry pine ſawduſt, which ſhould firſt be mixed with it; afterwards it ſhould be carefully weighed. It muſt then be ſtirred in a tumbler of water, and afterwards permitted to ſtand about five minutes. The gravelly and ſandy part will fall to the bottom;

the argillaceous part will remain ſuſpended in the water ſo much longer, as to form a diſtinct ſtratum above it; the ſoluble part will remain in the ſupernatant liquid over the argillaceous ſtratum.

After the five minutes, pour the liquid part into another veſſel. Then in more water ſtir up the gravel and argillaceous part again, and in a few ſeconds pour into another veſſel the argillaceous part, while it is ſtill ſuſpended in water, leaving the gravelly part. Next evaporate each part to dryneſs, making it as dry as at firſt. At laſt weigh each part ſeparately; which will give the proportions required.

Pulverized limeſtone is found to ſerve the double purpoſe of an earthy ſoil, and of exerting a peculiar action upon vegetables, ſomewhat analogous to the ſtimulant effects of gypſum. It will be found chiefly among the gravelly part, and may be detected by its effervеſcence with acids.

This method will give the proportions of the moſt eſſential conſtituents of ſoils, as it reſpects their fertility. A minute chemical analyſis may often be deſirable; but ſuch an analyſis will rarely be of material uſe to the Agriculturaliſt.

The proportions of the gravel and ſand to the alumine, in order to conſtitute the moſt ſuitable earthy ſoil, depends on the vegetables to be cultivated. Wheat requires a larger proportion of clay than Indian corn. Though the whole culmiferous tribe require more clay than the leguminous, cruciform or culinary tribes.

The beſt practical method for aſcertaining the excellencies and defects of ſoils is, to analyze by this method, ſpecimens of ſoils known to be good, and compare the reſults with the reſult of an analysis of the ſoil in queſtion.

VEGETABLE NUTRIMENT.

Common marl, being a combination of clay and limeſtone, may be detected by its efferveſcence with acids. The richneſs of marls depends on the proportion of carbonate of lime in them. That part may be wholly decompoſed by diluted muriatic acid, ſo as to form a limpid ſupernatant liquid, leaving the clay as a ſediment. It will therefore be perceived, that the proportions of theſe conſtituents may be readily aſcertained.

The carbonaceous mixtures in ſoils ſerve while cooling to abſorb nutritious gases from the atmoſphere, and to give them off to roots of plants while warming. This is proved by every practical chemiſt, by paſſing charcoal, decompoſed ſtraw, &c. through mercury into the various gases, which furniſh vegetable nutriment. Such as carbonic acid gas and ammonia; both of which are decompoſed by vegetable action, and one or both of their respective conſtituents incorporated with the ſubſtance of living vegetables.

Though charcoal, remaining in coal-pit bottoms, endures for ages without material decay, always performing the office of abſorbing and giving off the gases as before mentioned; yet looſe carbonaceous matter, as that which reſults from the decompoſition of ſtraw, &c. is probably conveyed, in part, into the ſubſtance of the plant. Conſequently requires to be frequently renewed.

Though earthy matters are often taken up and conveyed into the ſubſtance of vegetables, they may be conſidered as accidental. No ſubſtance can be conſidered as food for vegetables, which cannot be brought to a liquid or gaſeous ſtate at the common temperature. The gypſum undoubtedly acts as a ſtimulus to the living principle; exciting, as it were, the appetite of the plant to ſeize more greedily upon the nutritious materials within its reach. Theſe materials being principally furniſhed by the atmoſphere, (particularly the carbonic acid gas,) more carbonaceous matter is eventually added to the ſoil in the roots of clover and ſome other vegetables, in conſequence of the ſtimulant action of the gypſum.

Moiſt earth abſorbs the nutritious gases alſo. Such as ammonia, carbonic acid gas, carburetted hydrogen gas, &c. This is proved alſo by paſſing up dry, and damp earth, through mercury into different jars of the gases. This explains the cauſe of the great uſe of frequent hoeing and ſtirring the ſoil near plants; particularly in dry weather. The dried ſurface will not abſorb the gaſes which float in the atmoſphere; but the moiſt ſoil, which is preſented to the atmoſphere by hoeing, abſorbs them with avidity, and preſents them to the fine fibrous roots of plants.

ORGANIC RELICS.*

THESE foſſil relics are of two kinds. PETRIFACTIONS and CONSERVATIVES.

It is but one year (March, 1820,) ſince any perſon reſiding in the interior of our diſtrict, had any *practical* knowledge of Organic Relics. A fortunate incident at length preſented itſelf. The juſtly celebrated Le Sueur, the friend and companion of Cuvier, was called to Albany to perform ſome duties for the Commiſſioners for ſettling the boundaries between the United States and Canada. Being perſonally introduced to him by Profeſſor Mitchill, who happened at Albany, I availed myſelf of the advantages of his inſtruction for four weeks. Though my ſtock of knowledge in this department of Nature is ſtill very limited, I communicated all I knew to the members of the Troy Lyceum without delay. Being located in the vicinity of the Heldeberg, and other localities rich in theſe ancient treaſures; very conſiderable advances have already been made by this inſtitution. This sketch is intended to aid theſe inquiries in the moſt intereſting part of Geology, until ſomething better ſhall appear. A work on this ſubject is ſoon expected from John G. Bogert, Esq. of New-York, which will be adequate to the object.

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* This article is chiefly tranſlated from Martin'[illegible]STEMA RELIQUIORUM. Nothing more than a mere skeleton is offered; and that with a view to direct the learner one or two ſteps towards the arrangement of his collections.

PETRIFACTIONS, or SUBSTITUTIONS, are thoſe relics, which are entirely made up of mineral ſubſtances, which have gradually run into the places occupied by organized bodies as thoſe bodies decayed, and aſſumed their forms.

CONSERVATIVES, or PRESERVATIONS, are thoſe relics, or parts thereof, which ſtill conſiſt of the very ſame ſubſtances, which originally compoſed the living organized being.

An organic relic may partake of both kinds. The ſhell of an oyſter, being chiefly carbonate of lime, may ſtill remain, which would be a *conſervative.* While the encloſed animal matter will be entirely decayed and mineral matter occupy its place and imitate its form, which would be a *petrifaction.*

Organic relics are NAMED by annexing the termination *lithos* (a ſtone) to the ſcientific name of the living organized being. As ichthyolithos is compoſed of ichthus (a fiſh) and lithos (a ſtone.) That is, a fiſh becoming a ſtone. In Engliſh *lithos* is changed to *lite*, as *ichthyolite.* Sometimes the letter *l* is left out; as lacerta (lizard) would make *lacertite* (a petrified lizard.) This abridged method has now come into general uſe.

In order to prepare ourſelves for ſtudying organic relics, we muſt attend to the claſſification of Animals and Vegetables, while in the living ſtate. It is not neceſſary however, for the preſent object, to go very far into theſe departments of ſcience.

I ſhall follow Martin in dividing all organic relics into nine Genera, eight of which belong to the animal kingdom. Much the largeſt proportion of remains belong to Linneus' ſixth Claſs of Animals, which he denominates Vermes.*

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* Martin's Genera of Animal Relics, nearly correſpond with the Claſſes of living animals, excepting the Vermes. But he places all the vegetable kingdom in one genus.

ANALYSIS

Of Organic Relics.

When we undertake to aſcertain the name of a relic, we firſt determine to which of the nine genera it belongs. Frequently we can go no further for want of perfect parts, whereby to aſcertain the diſtinctive characters. Next we ſearch for the characters on which are founded the family name, then the ſpecific name. At laſt we ſearch for the ſub-ſpecies, if that ſpecies is ſubdivided.

We muſt always be careful to ſtop at that ſtep in the ſeries, where we are ſure we have not miſtaken the diſtinctive characters. For it is better to ſtop too ſoon, than to proceed to error. But we are not to expect all the characters perfect in any ſpecimen. We muſt often judge from one or two marks.

The firſt five genera are ſo very rare in our diſtrict, (few in truth having been found at all) that I ſhall merely give their generic characters and very ſhort deſcriptions.

Genus I. *Mammodolite.*

The Prototype[*] is the ſeparate bone or rarely entire skeleton of an animal of that claſs, whoſe young are nouriſhed by the milk of the dam. Found in recent ſtrata only.

Genus II. *Ornitholite.*

The Prototype is a ſeparate bone or bill of a bird; very rarely an entire skeleton. Found in recent ſtrata only; but rather older than the Mammodolites.

Genus III. *Amphibiolite.*

The Prototype is the bone of an amphibious animal; ſometimes the skeleton is found entire. Sometimes it is a naked skeleton, and ſometimes there is more or leſs of the remains of the ſcales, cruſt or armoury. Generally in recent ſtrata; but ſometimes not the moſt recent.*

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[*] Prototype ſignifies the original bone, or any other organized ſubſtance, of which the relic is a repreſentative in form.

Genus IV. *Ichthyolite.*

The Prototype is a ſeparate bone or the entire skeleton of a fiſh, often covered with the ſcales. Generally in recent ſtrata, but ſometimes not the moſt recent. Often in marl and bituminous ſhale.

Genus V. *Entomolite.*

The Prototype is the caſe or cruſt of an inſect; ſometimes entire and ſometimes mutilated. Generally in recent ſtrata; though ſometimes even in the oldeſt ſecondary.

Genus VI. *Helmintholite.*†

The Prototype is a worm or its inherent parts, particularly the harder parts. Species of this genus are found in ſtrata from the oldeſt tranſition to the moſt recent ſecondary.

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* The fleſhy part of any animal of this genus, or of the two preceding genera, has never been found petrified. The petrified ſnakes, ſo often reputed to have been found, are *cornu-ammonites*, of the genus *Conchbolite*.

† I commence with this genus, and hereafter give a tranſlation of Martin almoſt entire; becauſe ſpecimens of theſe four genera

This genus embraces moſt of thoſe jointed, rugged, cylindric relics; ſome of which reſemble a ſpinning-wheel whirl, others appear like branching, jointed roots; others are flattened or depreſſed and radiated or ſtar-like.

N. B. *Species* of organic relics nearly anſwer to the *genera* of living prototypes.

STIPED FAMILY.

The SPECIES of this family have a kind of ſtem or ſtipe.[*]

PENNATULITE. The Prototype of this genus in the living ſtate is the ſea-pen. The body is ſolitary, elongated, ſtiped, (free[†]) pinnate,

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are very abundant in our diſtrict. The French Naturaliſts have ſubdivided ſeveral of theſe ſpecies; but I am not able to give their characters; beſides it is not neceſſary for this ſhort outline.

[*] All the technical terms are defined in the Botanical Dictionary, publiſhed at New-Haven; now in common uſe throughout our diſtrict.

[†] That part of the deſcriptions included in parentheſis, though *found in living ſpecimens*, need not be ſought in petrifactions.

with a little inner bone (numerous little bones at the margin of the wings;) the wings are lateral, denticulate: ſtipe ſubulate.

ENCRINITE. Bodies radiated (a little mouth to each) and crowded together in umbels or whorls: the common ſtipe is ſimple and jointleſs, (furniſhed with a callous membrane.) The ſpecimens are generally ſtrait and reſemble ſpinning-wheel whirls. Very common in the Heldeberg, alſo near Hudſon and Catskill; particularly in the ſilicious ſandſtone, which accompanies compact limeſtone.

STYLASTRITE. Body moſt commonly radiated, (contractile, contracted) ovate or roundiſh, ſtiped, (mouth central) no aperture beſides the mouth; ſtipe columnar, perforated lengthwiſe, (furniſhed with a central medulla) often ſending off lateral branches (ſtoney;) generally jointed, with crenulate ſutures.*

SUB-SPECIES. ENTROCHITE. Stipe terete, with branches alternate, remote, and joints with circular grooves within; disk radiate-ſtriate: central ligament or perforation compounded from ſix filiform tubes, often producing a cavity obſoletely 5-lobed. It reſembles knotted jointed roots. Very abundant in Bethlehem caverns at the foot of the Heldeberg.

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* This ſpecies was taken from the ſpecies Isidite of the genus Briſmatolite by Martin; leaving thoſe jointed cylindric relics only, which are longitudinally ſtriated between the joints.

Sub-species. PENTACRINITE. Stipe angular, branches in whorls: disk of the joints marked with ſtellate forms, compoſed of five crenate oval rays. The central perforation ſimple. Martin ſays, this and the preceding ſub-ſpecies are found every where in lime ſtrata; but that entire ſpecimens, unbroken, can hardly be found.

Sub-species. ANTHOCEPHALITE.* Stipe long-turbinate, jointleſs, ſimple. Whether the body is five-cornered and five-toothed is doubtful. Found in the Heldeberg, but it is very abundant in Becraft's mountain near Hudſon.

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* Le Sueur labelled my ſpecimens of this ſub-ſpecies, Caryophillite. But Martin ſays, this name is given to a very different living genus of worms; therefore he adopts this ſubſtitute.

STIPELESS FAMILY.

The Species of this family are ſomewhat globular, or depreſſed like a flattened garden ſquaſh.

Asterite. Body depreſſed (coriaceous) often ſtellate, prickly, ſomewhat toruloſe; mouth central, having no other aperture.

Echinite. Body roundiſh (covered) cruſt bony, ſpiny (ſpines moveable): mouth below. I have ſeen a ſpecimen found in Hunt-ville, in the ſtate of Ohio.

Genus VII. *Concholite.*

The Prototype is a ſhell, produced by a moluſcous or ſoft animal deſtitute of jointed limbs. Species of this genus are found in ſtrata, from the oldeſt tranſition rocks to the moſt recent ſecondary.

This genus embraces the relics of proper ſhell animals; as of barnacles, oyſters, ſnails, &c.

MULTIVALVE FAMILY.

The Prototypes of Species of this family conſiſt of ſhells of more than two valves.

Chitonite. Valves often eight, rarely ſeven or ſix, tranſverſely oblong, lying on the back.

Lepadite. (Shell with the baſe affixed to ſome other body.) Valves many, unequal, erect; the little valves crowded together. The living prototype is called the *barnacle.*

Sub-species. **Balanite.** Moſtly ſeſſile, conic, the aperture terminal (having a lid.)

Pholadite. Principal valves two, divaricate, with acceſſory irregular little valves, hinge recurved.

BIVALVE FAMILY.

The Prototypes of the Species of this family conſiſt of ſhells of two valves. Probably nine-tenths of all the organic relics in our diſtrict belong to this family.

Myite. Valves moſtly equal,* unequilateral, often tranſverſely ovate, gaping at either extremity. (The hinge, moſtly, with one ſolid, thick, ſpreading tooth, not inſerted into the oppoſite valve.)

Solenite. Valves moſtly equal, unequilateral, oblong, gaping at both extremities. (Hinge with a ſubulate, reflexed tooth, often in pairs, not inſerted into the oppoſite valve.) Auſtin Abbott, Eſq. found one ſpecimen near Hudſon. It is now in the Troy Lyceum.

Tellinite. Valves moſtly equal, unequilateral, tranſverſely ovate or ſuborbiculate, towards the forepart it is bent to one ſide. (Hinge with three teeth, the ſide of one valve flat.)

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* Valves are *equal*, when they are ſimilar in form and ſize; as the two ſides of the common clam-ſhell. They are *unequilateral*, when what lies towards the edges on each ſide of the hinge is not equal; as the common clam-ſhell alſo.

Cardite. Valves equal, ſomewhat equilateral, ſub-orbiculate, moſtly very convex, longitudinally ribbed, ſtriate or furrowed ; margin toothed. (Hinge with middle teeth in pairs, alternating with each other in the oppoſite valves, one generally incurved.)

Mactrite. Valves equal, unequilateral, tranſverſely ovate, or three-cornered. (Hinge with the middle tooth folded in with an adjoining cavity, lateral ones inſerted remotely.)

Donacite. Valves equal, unequilateral, often ovate or wedgeform, margin moſtly crenulate, very obtuſe at the forepart. (Hinge with two teeth.)

Venerite. Valves equal, unequilateral, often ovate orbiculate, lips with a fore margin. (Hinge with three teeth ſtanding near each other and diverging.) I found one in Blenheim in graywacke.

Spondylite. Valves unequal, unequilateral, often ſuborbiculate, rigid, ſometimes a little auricled. (Hinge with two teeth, recurved, *with* an intermediate cavity.)

Chamite. Valves often ſubequal, moſtly unequilateral, roundiſh, thick. (Hinge callous gibbous, inſerted obliquely into an oppoſite cavity.) I found one ſpecimen in the Heldeberg in the ſilicious ſandſtone.

Arcite. Valves equal, unequilateral, oblong or roundiſh; hinge generally ſtrait, rarely curved. (Hinge with numerous teeth.)

Ostracite. Valves unequal, unequilateral, not auricled, rough, moſtly lamellated, not radiated, oblong, generally narrowing a little towards the hinge. (Hinge toothleſs.) I found one very fair ſpecimen in the ſilicious ſandſtone in the Heldeberg; and I ſaw hundreds of a very large ſize at Glen's Falls in Saratoga county.

Pectinite.* Valves auricled, radiated, equilateral; hinge ſtrait. The ſtrait hinge is the beſt character in petrifactions. Very abundant in the Heldeberg, Hudſon, Catskill, Glen's Falls, &c.

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* Martin makes this a ſub-ſpecies of Oſtracite, following Linneus. But the French naturaliſts make it a diſtinct genus among living ſpecimens; of courſe a diſtinct ſpecies among relics.

There are ſeveral varieties of Pectinites and Anomites in our diſtrict, which, for the preſent, may be diſtinguiſhed by a deſcriptive adjective; as Cordate, Ovate, &c.

Anomite. Valves unequal, equilateral; the point of one valve extending beyond the other at the hinge, either ſtrait or incurved. The moſt common of all relics in the Northern ſtates. In the Heldeberg it is often found very large. Sometimes the inſide preſents appearances, which are miſtaken for tortoiſe ſhells, deer's hoofs, &c. by the common people.

Sub-species. **Gryphite.** One valve flattiſh, the other much curved at the hinge. With ſhallow rays or none. Very abundant in the Heldeberg.

Sub-species. **Terebratulite.** Valves both convex, radiated with grooves, often large and deep, upper one becoming much narrower near the hinge and curved. Very common in the Heldeberg, Hudſon, Catskill, Glen's Falls, on the ſhores of Lake Ontario, &c.

Mytilite. Valves equal, unequilateral, obliquely or longitudinally ovate, rough. I found one in graywacke in Blenheim, and Mr. Cyrus M. Stebbins found one near Hudſon. Both are in the Troy Lyceum.

SUB-SPECIES. MARGARITIFERITE. Valves auricled, ſomewhat compreſſed; hinge ſtrait, extended.

PINNITE. Valves subequal, unequilateral, erect, triangular, gaping, often rough-ſcaly.*

UNIVALVE FAMILY.

The Prototypes of the SPECIES of this family conſiſt of ſhells of a ſingle piece, as the ſnail-ſhell.

NAUTILITE. Shell chambered with perforated partitions, chambers numerous.

SUB-SPECIES. AMMONITE. Spiral, with the apex in the center, ſometimes a little elevated, ſometimes depreſſed. Found rarely at the Heldeberg, Lake Ontario, &c.

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* At leaſt three-fourths of all the organic relics conſtituting the Heldeberg, Glen's Falls in Saratoga county, and Becraft's mountain at Hudſon, are Pectinites and Anomites with the ſub-ſpecies.

Sub-species. Rectiusculite. Strait a little diſtance, and ſpiral near and at the apex. Auguſtus Sacket, Eſq. ſhewed me ſeveral large ſpecimens found at Sacket's Harbor.

Sub-species. Orthocerite. Strait from the baſe to the apex, and chambered all the way. This has the appearance of the vertebrae of animals. Very abundant and large near Lake Ontario. Common in the Heldeberg and ſometimes found at Hudſon. One was found in argillaceous ſlate at the north end of Troy.

Sub-species. Belemnite. Strait, elongated; having a conic chambered cavity at the baſe, but ſolid at and towards the apex.

Sub-Species. Trilobite.* Baſe three-lobed; from the baſe to near the apex the body appears as if longitudinally divided into three rows of chambers. Called petrified miller by the common people when ſmall; when large they conſider it the petrified ribs of animals. Very abundant in Becraft's mountain near Hudſon, both in graywacke and compact limeſtone. It is frequently found at the Heldeberg alſo.

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* This ſub-ſpecies is not deſcribed by Martin; neither have I ſeen a deſcription of it. I drew this deſcription from my ſpecimens, which were labelled by Le Sueur.

CONITE. Shell convolute, turbinate; aperture effuſe, linear, toothleſs, entire at the baſe, columella ſmooth.

CYPRAEITE. Shell involute, ovate, ſmooth; aperture effuſe at both ends, linear, toothed both ſides.

BULLITE. Shell convolute, ſmooth; aperture contracted, oblong, running lengthwiſe, entire at the baſe; columella oblique, ſmooth.

VOLUTITE. Shell ſpiral; aperture without any beak, ſomewhat effuſe: no lip on the inner ſide of the aperture. We have received at the Troy Lyceum very minute ſpecimens, in lenticular argillaceous iron ore, from the ſouth ſide of Lake Ontario, preſented by A. Cole, Eſq.

BUCCINITE. Shell ſpiral, gibbous; aperture ovate, terminating in a channel twiſted to the right: inner lip ſpread, ſmooth.

STROMBITE. Shell ſpiral, enlarged towards one ſide: aperture often with a ſpread brim, terminating in a canal turning to the left.

Muricite. Shell ſpiral, prickly with membranaceous ſutures: aperture terminating in an entire canal, ſtrait or ſomewhat aſcending.

Trochite. Shell ſpiral, ſomewhat conic: aperture ſomewhat four-cornered, tranſverſe above, contracted: columella oblique. A ſpecimen was ſent to the Troy Lyceum by the Rev. N. M. Wells, found at Sacket's Harbor.

Turbinite. Shell ſpiral: aperture contracted, orbicular, entire. This ſpecies is often miſtaken for the ammonite; but it may be diſtinguiſhed by its elevated apex and want of tranſverſe partitions between chambers. Frequently found in the Heldeberg, near Hudſon, at Glen's Falls, &c.

Helicite. Shell ſpiral; aperture contracted, lunate or roundiſh within, or the ſegment of a circle cut off. It is depreſſed, globoſe, ovate, or ſomewhat conic.

Nerite. Shell ſpiral, gibboſe, flattiſh beneath: aperture ſuborbicular; lip of the columella tranſverſe, truncate, flattiſh.

Haliotite. Shell earform, ſpreading:

ſpire concealed, lateral: disk longitudinally perforated with pores.

Patellite. Shell ſubconic, without any ſpire.

Dentalite. Shell tubular, free, perforated or pervious at both ends, without a ſpire, ſtrait.

Serpulite. Shell tubular, adnate, often contorted, entire at one extremity.

Genus VIII. *Erismatolite.*

The Prototype is the prop, ſupport or habitation of a worm or kind of polypus, which was produced by itſelf. Found in all ſtrata from the Graywacke to the moſt recent rock.

This genus embraces thoſe relics, which, in the living ſtate, are called Corals and Corallines.

CORAL FAMILY.

The Species of this family have the ſupport or habitation outſide of the animal, and it is generally pretty thick and ſtrong.

Tubiporite. Habitations tubular, ſtoney, often aggregated: tubes moſtly connected by partitions, or tubular branches.

Madreporite. Support or habitation ſtoney: cells or naked habitations ſtellate with radiating laminae.

Sub-species. Reteporite. Surface preſenting a checked net-like appearance. Found at the Heldeberg. I have no deſcription of this; but my ſpecimen was labelled by Le Sueur.

Sub-species. Fungo-madreporite.* *(Madrepora simplex.)* Support ſingle: laminae in a ſingle ſet of rays. Profeſſor Silliman has a very perfect ſpecimen; it appears like a common agaric, with a concave pileus or cap.

Sub-species. Cornu-madreporite. Support with its lamellar longitudinal rays hornform. Very abundant in the Heldeberg, at Hudſon, Lake Ontario, &c.

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* Martin ſays, this has been deſcribed by ſome authors as a petrified agaric: but that ſuch a petrifaction has never been found.

SUB-SPECIES. ARBO-MADREPORITE. Stalk ſhrub-like.

SUB-SPECIES. CUMULO-MADREPORITE. Stalks united together, often forming an entire maſs; ſometimes they are more or leſs diſtinct.*

MILLEPORITE. Habitation ſtoney: cells in the form of pores. Often branched.

CELLEPORITE. Habitation ſomewhat ſtoney: cells cup-form. Very abundant in the Heldeberg and near Lakes Ontario, Erie, &c.

ALVEOLITE. Habitations ſtoney, covering other bodies, or in a ſimple maſs, formed of concentric layers which are compoſed each of an union of numerous alveoles. The alveoles are very ſhort, contiguous, reticulate and generally parallel.

FAVOSITE. Habitation ſtoney, ſimple, of a variable form; compoſed of parallel, priſmatic, faſcicled tubes, which are five or ſix-ſided.† Called petrified waſp-neſts. Very abundant in the Heldeberg. Faſcicular Favoſite, is called a petrified knot at Lake Ontario.

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* Theſe may be conſidered rather as deſcriptive, than technical, names.

† I took theſe two laſt deſcriptions from Say's excellent article

CORALLINE FAMILY.

The Species of this family have the ſupport outſide of the animal, and it is generally very ſlender and often branching.

Sertularite. Support often jointed (horn-like) ſhrubby, tubular: receptacles diſpoſed often laterally, cup-form or teeth-form,

Tubularite. Support often jointed (horn-like) tubular: tubes continued or branched, often jointed: mouths terminal.

Flustrite. Support often continued, foliaceous, compoſed of an united ſeries of ringent cells.

Corallinite. Support jointed, often dichotomous (filamentoſe:) porous on the outſide (calcareous.) Very abundant at Glen's Falls in Saratoga county. Perhaps a variety in

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on Foſſil Zoology in the American Journal of Science, pages 383 and 384.

red ſandſtone on Cattskill mountains, in Blenheim near the head of the Delaware, &c.

CRUSTY FAMILY.

The Prototype of this family conſiſts of a woody or ſtoney ſtalk, covered with a bark-like cruſt.

Isidite. Support (ſtoney) ſhrubby, jointed between the knots; joints longitudinally ſtriated. I found one imperfect ſpecimen in the Heldeberg. Capt. Dowd preſented a ſmall, but very well characterized, ſpecimen to the Lyceum, from near Geneſee river.

Gorgonite. Support (woody, teſtaceous or horn-like) ſhrubby, continued.

FAMILY DOUBTFUL.

Alcyonite.[*] Support is a proper ſtipe, with a pileus or cap compoſed of radiating tubes. In form it reſembles a ſtiped agaric. One ſpecimen found in Bethlehem cavern by Mr. A. P. Heartt was preſented to the Troy Lyceum.

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[*] This ſpecies was labelled by Le Sueur. As I cannot procure the French deſcription, I am compelled to deſcribe it from the external appearance of the ſpecimen. This may ſerve until ſomething better appears.

Genus IX. *Phytolite.*

Prototype ſome part of a plant; either root, trunk or leaf.

Muscite. Some part of a moſs. Stem diſtinct, filiform: leaves ſimple, generally crowded together, imbricate, ſeſſile.

Filicite. Some part of a Fern. Leaves moſtly pinnate or pinnatified. Very fine ſpecimens found at the Rhode-Iſland coal mines.

Graminite. Culm moſtly jointed: leaves ſimple, lance-linear. The culms of an unknown ſpecies of graſs I found in the Heldeberg, in ſilicious ſandſtone.

Palmite. Body of the ſtem or root ſimple with the apex leafy.

Lignite. The body or limb of a tree. We have excellent ſpecimens from the Mobile in the Troy Lyceum. Alſo tolerable ſpecimens embraced in calcareous tufa from near the weſt boundary line of Madiſon county, N. York.

Rhizolite. Any part of a root. We have a ſpecimen in the Lyceum, embraced in calcareous tufa from the ſame locality as the *laſt above.*

INDEX

TO THE

Geology of the Northern States.

I. PRIMITIVE CLASS.

STRATUM 1.

GRANITE.

Spencer Range.[*]

THE granite of the Northern States may be divided into five ranges. This will not embrace the granite of the State of Maine, nor the ſhort patches near the eaſtern ſhores of Maſſachuſetts above and below Boſton Harbor.[†] A faithful view of theſe ranges, however, will be abundantly ſufficient for preſenting the ſcience of Geology, in that elementary form, which is intended in this Index.

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[*] I ſhall diſtinguiſh the ranges by the names of the towns through which they paſs in the line of our ſection; which is laid, ſo as to average a few minutes north of the 42° of N. Latitude. A very broad belt, from ten to forty miles is taken into view for fixing the order of ſtrata.

[†] Meſſrs. Danas ſay, *that no formation of granite is found in the vicinity of Boſton.*

The broadeſt and the moſt uniform in its breadth of all the five ranges given in our ſection, is that which paſſes through the town of Spencer, Maſs. The White Hills of New-Hampſhire, which M. Rafineſque calls the Nucleus of New-England, belong to this range. The extent of the granite, in that vaſt pile of mountains (which has not yet been traverſed by a Sauſſure) is not aſcertained. From the beſt obſervers we learn, that it is principally Gneiſs.

This range commences on both ſides of Connecticut river at its mouth. Inclining a little eaſterly, it leaves that river to the weſt, near the north bounds of the town of Haddam. It holds a great breadth as it extends northerly through the towns of Bolton, Stafford, &c. Con. Brimfield, Sturbridge, Spencer, &c. Maſs. On its courſe through New-Hampſhire to Canada it varies its breadth conſiderably. Sometimes *approaching* near to Connecticut river; at others leaving conſiderable breadth for the tranſition and ſecondary claſſes on its eaſtern ſhore.

Wherever I have examined this range it is generally very coarſe-grained and of the grey variety. Though elegant ſpecimens with the fleſh-coloured felſpar frequently occur. In Haddam the felſpar is of a beautiful pearly white; and often in blocks of more than a foot in extent. The mica is variouſly coloured, and frequently very beautiful.*

At Saybrook Profeſſor Silliman found well-characteriſed ſpecimens of lamellar ſulphuret of molybdena in this rock. In Haddam Col. Gibbs and Mr. Silliman have diſcovered vaſt quantities of beryl, ſome emerald and chryſoberyl. Mr. Mather found a cryſtal of beryl here nine inches in diameter. I collected here about fifty elegant ſpecimens of beryl, ſome of them very large, one fine ſpecimen of emerald and conſiderable chryſoberyl, for the

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* My ſon, A. B. E. found at Haddam a ſpecimen of ſilver-coloured mica with a jet-black belt traverſing the ſame plates. Alſo a maſs of hexahedral cryſtals of mica two inches in diameter, with four of the ſides perfect and unbroken. They are now in the Troy Lyceum.

Troy Lyceum, notwithſtanding many cabinets had previouſly been ſupplied from the ſame locality.

In Brimfield I found the moſt beautiful adularia ſubſtituted for felſpar in both granite and gneiſs. Small four-ſided cryſtals of zircon, terminated by four-ſided pyramids, of the colour of ſmoky quartz were found in connexion with the adularia in a wall near the reſidence of the late General William Eaton, by his daughter.* Lamellar ſcales of plumbago are often diſſeminated in granite and gneiſs in Brimfield and Sturbridge; and Dr. A. Lincoln found ſulphuret of molybdena in granite in the weſtern part of Brimfield. In the White Hills of New-Hampſhire at Roſebrook's Gap, Col. Gibbs found green fluate of lime.

Throughout the whole extent of this range, as far as I have examined, it paſſes laterally under the gneiſs both to the eaſt and weſt.

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* Jameſon found zircon in gneiſs. See Bruce's Journal, page 261. And I have one ſpecimen of gneiſs found in Brimfield containing zircon.

Shrewsbury Range.

Proceeding eaſterly, the granite appears again in Shrewsbury, eaſt of Worceſter. This range is remarkably fine-grained, and of a light grey colour. It yields to the chiſſel ſo readily, that it it is much uſed for building-ſtone. It extends into New-Hampſhire acroſs the Merrimack river; down which and the canal vaſt quantities are tranſported to the State-Priſon, where it is manufactured by the convicts for the Boſton market. It has now become ſo common for buildings, flagging ſide-walks, ſtreet-poſts, pillars, &c. in the town of Boſton, that an eaſtern traveller, on viſiting it, might fancy himſelf tranſported to Grand Cairo in Egypt.

This range ſinks under the gneiſs towards the eaſtern part of Shrewsbury and does not riſe again weſt of the Atlantic, in the courſe of our ſection.

Northampton Range.

Returning on our ſection to the weſt, the granite ſinks under the gneiſs near the eaſtern part of Brookfield. It appears frequently in deep vallies at various intervals much farther to the weſt. There is one direction, where the granite of the Spencer range, can be traced along under the other ſtrata and under Connecticut river, entirely into the Northampton range. Though it cannot be ſeen all the way, we fall in with it at ſuch intervals and in ſuch relations, that the moſt ſceptical will not doubt. The beſt courſe for this examination lies from Brookfield northweſterly to Leverett, thence to Whately and Williamsburg. The gneiſs and the higher ſtrata cover the granite, excepting in the deep valleys and at other low levels. It diſappears entirely for a little diſtance, when it paſſes under the ſecondary ſtrata and under Connecticut river.

The Northampton range commences in the ſtate of Connecticut and may be a branch of the Hinſdale range; or rather this and the Hinſdale range probably ſpring from the ſame root weſt of New-Haven. I have no doubt but the granite at Canton in Connecticut belongs to this range. I have traced it from near Connecticut line in Southwick along the weſt bounds of Weſtfield, near the eaſt bounds of Montgomery and the weſt of Southampton, near the weſt bounds of Northampton, and into Hatfield and Whately. Here it diſappears by dipping under the higher ſtrata; and it is ſuppoſed to riſe again near the ſouth line of Vermont.

Although I do not intend to account for any of the errors of the firſt edition of this Index, but to preſent facts as I now underſtand them; yet as a range of granite paſſing through Cheſterfield has been adopted by many learned American geologiſts, it will be expected that I ſhould give my reaſons for this innovation.

After examining the granite in Cheſterfield and Goſhen very attentively, I find that it is always in the form of veins traverſing gneiſs. The large maſs in Cheſterfield village, which ſeems to have given character to the whole ſuppoſed range, is certainly a mere vein, encloſed by diſtinctly characterized gneiſs walls. This ſubject requires no train of reaſoning; I aſſert the fact and invite geologiſts to countenance or contradict me, after inſpecting the rock. Even the vaſt bed of granite two miles northweſterly from Cheſterfield village, mentioned by Col. Gibbs* as traverſed by "a falſe vein of ſilicious felſpar and quartz," is itſelf a vein traversing gneiſs. Col. Gibbs ſays, the bed of granite in Goſhen, ſix miles north of Cheſterfield, which contains the blue tourmaline, roſe mica, &c. has not been diſcovered. If the range of looſe rocks in which they are found be purſued northerly a conſiderable diſtance, I think it becomes pretty evident, that thoſe fragments proceeded from a vein in gneiſs. Though I confeſs we are compelled to reaſon from analogy in a great meaſure.

I have obſerved, that veins of granite, when found in gneiſs, abound in tourmaline, and the faireſt ſpecimens of mica, and often contain beryl. Such is certainly the fact in Haddam and Litchfield, Con. and in Cheſterfield and Goſhen, Maſs. While the oldeſt granite, as that in the Spencer range, preſents but few ſpecimens of tourmaline, and the mica is generally of but one variety.

I had much difficulty in adjuſting primitive rocks in New-England in ſyſtematic order, while I conſidered thoſe vaſt veins as indicating the place of granitic ſtrata. But ſince I have attempted to ſeparate veins from ſtrata, all the difficulties are obviated.

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* See American Journal of Science, page 348.

I will point out to the reader another locality, which I think will very clearly illuſtrate this poſition. In Goſhen, one mile eaſt of the blue tourmaline locality, mentioned by Col. Gibbs, in an open field, a little to the ſouth of a Beaver-pond, is a gneiſs rock, laid bare to a conſiderable extent. Here is a vein of very coarſe grey granite, fair to the view, from ſix to twelve feet wide with almoſt an even ſurface, and ſeveral rods in length; vertical and embraced between walls of very diſtinctly characterized gneiſs. Veins of this kind, though not of equal extent, appear near Leiceſter Academy; alſo traverſing hornblende rocks in Belchertown.*

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* Extract from a letter to Dr. A. Robbins, the Correſponding Secretary of the Troy Lyceum, which I wrote, while acting as Collecting Agent—dated Danbury, Con. Nov. 19, 1818: "Much is yet to be done, before even the outlines of the Geology of this country is ſettled. Among other ſubjects the granite itſelf ſeems to be too incorrigible to ſubmit to the Wernerian arrangement. After I am better prepared I intend to remark extenſively upon

This range ſeems to lie very near the ſurface. For it frequently appears in large patches where the upper ſtrata ſeem to have paſſed away. Dr. David Hunt, who has every mineral in this part of the ſtate at his call, conducted me to a quarry of the fine-grained granite, but a ſmall diſtance weſterly from Northampton village.

The lead mines of Southampton and Hatfield are in this range. Mr. Hitchcock found lead ore, with moſt of the accompanying minerals which are found in the Southampton mines, at Whately and Leverett. This affords one of the beſt evidences, that this range of granite paſſes under Connecticut river, ſupporting the upper ſecondary and alluvial formations.

Where this range paſſes along the weſt bounds of Weſtfield, four miles weſt of the Academy, in the woods north of the Ruſſel road, I diſcovered a very extenſive bed of ſerpentine, em-

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this ſtratum. At preſent I am compelled to ſtate, that wherever I have examined, it appears rather in veins traverſing gneiſs and hornblende rock, than as a diſtinct ſtratum. I do not feel inclined to any ſuch new doctrine. I merely intend to confeſs, that after much minute inveſtigation for three years paſt, I am ſtill embarraſſed with this part of the ſyſtem of arrangement."

braced in granite. It is exactly upon M'Clure's Springfield geological ſection. The ſurface of the ſerpentine exhibits the deſtructive effects of diſintegration. But on examining it in the fiſſures, it appears to be ſufficiently compact for quarrying. I have no doubt it will, at ſome future day, become a profitable quarry. Towards the ſouth end of the bed, beautiful talc is very abundant.

In the lead mines of Southampton, Dr. Hunt, Col. Gibbs, Profeſſor Silliman and Dr. Meade have found many intereſting minerals. Sulphate of barytes, ſulphuret of zinc, ſulphate of zinc, ſulphuret of copper, ſulphuret of lead, ſulphate of lead, muriate of lead, molybdate of lead, fluate of lime, beautiful radiated quartz, &c. Moſt of theſe minerals have been diſcovered at Hatfield alſo. Mr. Silliman obſerves, that this vein extends from Montgomery to Hatfield, a diſtance of twenty miles. Bruce's Journal, page 64. Mr. Hitchcock has now traced it to Whately and acroſs Connecticut river to Leverett. I have traced the ſame granitic range and found it embraced ſimilar imbedded minerals, nearly to the ſouth bounds of the ſtate of Maſſachuſetts. Although I diſcovered no lead ſo far ſouth; I think, from a conſideration of the minerals with which the lead is aſſociated, that it is probable the vein extends nearly acroſs the ſtate of Maſſachuſetts, and perhaps farther.

Hinsdale Range.

Proceeding to the weſt, the Northampton range of granite paſſes under the gneiſs, and appears again near the foot of the mountain of Peru on the weſt ſide, in the town of Hinſdale. Here as well as at Northampton we have a ſpecimen which is fatal to that part of Werner's theory, which requires that the granite ſhould be the higheſt in ſimilar ſituations. The granite ſupports the gneiſs on its eaſtern ſide, ſeveveral hundred feet higher than itſelf. A ſimilar relation between theſe two ſtrata is preſented in Saratoga county, which will be deſcribed hereafter.

The Hinſdale range of granite commences on the weſt ſide of Houſatonic river, a little north of Bridgeport, in Connecticut, and extends in a northerly direction, probably uninterrupted, until it paſſes the bounds of Canada. I have traced it through moſt of Litchfield county, and find it paſſes out of the ſtate through Norfolk. I have purſued the ſame range acroſs Maſſachuſetts; and Dr. Edwin James has traced it thence moſt of the way to Canada. It is very ſtrange, that ſeveral publications have located the ſouthern extremity of this primitive range in Weſt Rock, at New-Haven; which is greenſtone reſting on red sandſtone. Such random guesses, given as facts, are very injurious to the ſcience.

Moſt of this and the Northampton ranges are remarkable for being at a lower level than the gneiſs and hornblende rocks. Sometimes they are even lower than the mica-ſlate and talcoſe rock. It preſents all the varieties of colour and texture. In Litchfield county, Con. we find the felſpar pearly white and bright fleſh red. Alſo the moſt beautiful ſpecimens of graphic granite; particularly in the town of Bethlehem. Where it croſſes our ſection at Hinsdale the felſpar is generally dirty white. In Adams, twenty miles north of Hinſdale, the quartz is purpliſh blue; and ſometimes the felſpar is a bright blue. Fragments of the latter variety have been found, of ſeveral hundred pounds weight, in the alluvion near Troy; more than thirty miles out of place.

Near the ſouthern extremity of this range, in the town of Huntington, Con. Mr. Silliman found in it, tungſten, tellurium, native bismuth, &c. In Litchfield county, Mr. John P. Brace conducted me to localities, where it contained beryl, ſmoky quartz, tremolite, chalcedony, petro-silex, ſhorl, &c.; but the principal rock in this county is gneiſs, and it generally contains ſimilar minerals to thoſe found in granite. In Woodbury it contains magnetic iron pyrites, and in Roxbury carbonate of iron; though probably the latter mineral is in a vein of granite in gneiſs.

I have ſeen ſeveral very intereſting minerals from this range in the ſtate of Vermont. But little authentic account of particular localities has been received. Dr. Edwin James preſented to the Troy Lyceum an aggregated maſs, from this range in the town of Charlotte, of pearly white felſpar, whitiſh quartz, green augite, green and red coccolite and laminated plumbago. This had been long ago diſcovered by Profeſſor Hall as the locality of coccolite; and it ſeems that the celebrated Rogers' Rock is chiefly a maſs of a ſimilar aggregate. But I had never before ſeen ſuch large cryſtals of green augite. Dr. Wells received a ſpecimen from Rogers' Rock containing one ſlender tranſparent cryſtal. He alſo received, and preſented to the Troy Lyceum, a ſpecimen of native biſmuth, which was picked up in a ſmall creek near Ticonderoga. This probably pro~~ceeded from one of the granite rocks~~ in that vicinity. But whether from the eaſtern or weſt~~ern range, it is difficult to determine.~~

The granite of New-York Iſland has never been traced, to my knowledge, ſo far as to aſcertain to which range it belongs. Whether it is an interrupted ſpur from the Hinſdale range, diverging from it in the ſouthweſt part of Connecticut, or inſulated and independent, I can at preſent obtain no means of determining. It ſeems to be accompanied by gneiſs, ſienite, mica-ſlate, talcoſe rock, granular limeſtone, &c.

It preſents ſeveral varieties. Dr. John Torrey has ſhown me ſpecimens of the red and grey; and the Rev. F. C. Schaeffer found the graphic variety.

Saratoga and Highland Range.

The Hinſdale range of granite ſinks laterally under the gneiſs to the weſt. All that part which is included between Vermont and Litchfield, Con. never riſes again this ſide of the Rocky Mountain at the head of the Miſſouri. Whether it riſes again this ſide of the Pacific ocean we are not able to determine at preſent; as we have not yet received any ſatisfactory account of the Rocky Mountain.*

I ſay that part, which is included between Vermont and Litchfield; becauſe Dr. Steel has treated the Saratoga, and Highland, granite as the ſame range.† And as I can ſee no inconvenience in ſuch a view of the ſubject, I ſhall follow him.

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* We ſhall no longer remain ignorant of the conſtituent ſtrata forming that mountain, after Dr. Edwin James, and Mr. Henry R. Schoolcraft, who are attached to the weſtern ſcientific expedition, ſhall have ſet foot upon it.

† See Steel's Analyſis of Mineral Waters, 2d Ed. page 20.

This is the moſt extenſive range in North America. It commences, according to M'Clure, in Georgia. It continues, with little interruption, through all the ſtates in its courſe northeaſterly, as far as Dutcheſs county in the ſtate of New-York. There it ſinks gradually beneath the upper ſtrata and riſes again one mile north of Saratoga Springs. Thence it continues on with but few interruptions into the unexplored regions of Upper Canada.*

The appearance of the granite in Saratoga county is very remarkable. Without a view to any particular theory, its appearance may be repreſented by the following ſuppoſition. That all the ſtrata now in view formerly lay in a horizontal poſition; with the granite at the bottom and the compact limeſtone at the top, covering the whole country. That a force was applied beneath the granite, ſufficient to raiſe it up with all the upper ſtrata on its back. But at this place it happened to break through them all at once, forming a north and ſouth fiſſure of thirty or forty miles in extent. All the ſtrata on the eaſt ſide of the fiſſure fell back nearly entire, and ſtill remain ſo; with the compact limeſtone covering the whole as it did while all the ſtrata lay undiſturbed. But on the weſt ſide the ſtrata ſtill retain the elevations to which they were raiſed. For about ten miles from the ſouth extremity, the granite ſhows only its eaſtern edge, and that but a few feet higher than the eaſtern plain; while it ſupports the gneiſs, hornblende rock and mica-ſlate of ſuch thickneſs, as to form over it a mural mountain. Wherever the rock is laid bare on the eaſt ſide of the ſuppoſed chaſm, it is compact limeſtone; which in ſome places meets the granite ſo cloſely, that it may be compared to a board ſcribed up to a wall by a carpenter.

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* Perhaps future inveſtigations may prove the Highland range to be more properly united to the Hinſdale; and that the northern part which extends down from Canada, terminates at Saratoga. This is M'Clure's plan, as laid down on his Geological Map; though he does not profeſs to be minute in the minor localities. An accurate geologiſt ought to explore the country from the Highlands to Saliſbury mines; and from New-York Iſland to Danbury, in Connecticut.

Where the river Hudſon cuts through the mountains, about twenty miles north of Saratoga, near Glen's Falls, the granite riſes much higher. Here, at its eaſtern baſe, the compact limeſtone, conſiſting moſtly of organic relics, is waſhed bare by the river. A teacher of Geology might here arrange his pupils, ſo that they might inſpect ſpecimens in place of the primitive, tranſition, ſecondary and alluvial claſſes, on a vaſt ſcale. And at the ſame time they might all ſit within the ſphere of his voice, but for the roarings of the mighty Hudſon, ruſhing down from the ancient granite to the recent formations below.*

Lamellar ſcales of plumbago are diſſeminated through the granite at a place about ſeven miles north of Saratoga Springs. In a hole dug about ten feet into the ſolid granite, the walls preſented a beautiful glimmering appearance, cauſed by the diſſemination of ſcales of plumbago.† I believe molybdena has been found here alſo; but I loſt my ſpecimens before I teſted them. The felſpar is generally white, and I found a few ſpecimens of adularia. Cubic maſſes of magnetic oxyd of iron are not uncommon.

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* For the geology of Saratoga county, with a complete geological map, the reader is referred to the Introduction to Dr. Steel's Analyſis of Mineral Waters, 2d Ed. publiſhed at Albany.

† This hole was dug by a deluded company of money-diggers. About half a dozen robuſt young men were at work when I viſited the place, Dec 1818. They were encouraged by one of thoſe impoſtors, who pretends to ſee hidden treaſures by looking into

At the Highlands the granite embraces large beds of very hard ſerpentine. The granular magnetic iron ore, containing ſmall cryſtals of yellowiſh phoſphate of lime, is abundant in the Highlands, embraced in both granite and gneiſs. I believe every known variety of granite is found here.

I have been able to aſcertain but few localities of diſſeminated minerals at the Highlands. Neither have I learned in which particular ſtrata the many minerals brought from there were found. Mr. S. W. Conrad found cryſtals of zircon in this range, where it paſſes through New-Jerſey. I have ſeen cryſtals of beryl in granite paving ſtone, which were brought to Albany from the Highlands; but know nothing of the particular localities of them.

a magic mirror. When I attempted to convince them of their error, their magician told them that I wiſhed to perſuade them to *deſiſt, that I might* come and take the treaſure.

It has been the received opinion, that there was no granite weſt of this range in North America; or at any rate not on this ſide of the Rocky Mountain. But it appears from the obſervations of Mr. Henry R. Schoolcraft, that there is a low range of granite, reſembling the Northampton range, of a ſimilar variety and containing ſimilar minerals, on the weſt ſide of the Miſſiſſippi, paſſing northerly perhaps through the ſtate of Miſſouri. The lead mines, with the accompanying minerals, blende, ſulphate of barytes, fluor-ſpar, radiated quartz, &c. are found in the courſe of this range for ſeven hundred miles.*

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* See Schoolcraft's View of the Lead Mines of Miſſouri, pages 92, 118 and 193.

Range east of Shrewsbury.

The gneiſs commences in the eaſtern part of Shrewsbury and continues to the foot of the hill weſt of Framingham. There are ſeveral valleys, at the bottom of which we find granite. Some of the hills preſent fields of hornblende rock in their higheſt parts; and patches of mica-ſlate ſometimes, though rarely, occur. The alluvion hides the rocks to conſiderable extent near the ſtage road; but on examining the country north and ſouth for ſeveral miles, I became convinced that gneiſs is generally the baſis rock. I found ſeveral beds of calcareous ſandſtone, which induced me at firſt to conſider it a ſtratum analogous to one of the ranges of granular limeſtone weſt of Hinſdale. But I have ſince become familiar with ſuch beds. I find them very nearly reſembling ſand-like limeſtone aggregated with quartz, imbedded, for miles in extent, in the gneiſs of Saratoga. Bakewell and other European geologiſts, mention the occurrence of ſimilar aggregates in gneiſs.

Near Framingham this range paſſes under diſtinctly characterized hornblende rock. It does not appear again as the principal rock, in the eaſtern part of our ſection.* But the three lower primitive ſtrata ſeem to lie nearly in a horizontal poſition, the loweſt of which being at no great depth, throughout the whole extent of country from Shrewsbury range of granite to the Atlantic. For wherever we deſcend into the deepeſt valleys, we reach the granite, with gneiſs and hornblende rock reſting upon it in ſucceſſion, in almoſt every part of this portion of our diſtrict. In truth there are ſeveral extenſive tracts of country in the New-England ſtates, where theſe three ſtrata, and ſometimes two or three of the next in ſucceſſion, may be diſtinctly ſeen lying upon each other, as we aſcend from valleys of moderate depths to the tops of adjoining hills. Here we are relieved from all the uncertainties of theory. For we actually ſee a ſucceſſion of eminencies, in which the ſtrata now retain their original order; while the uppermoſt are cut off by the intervening valleys. Monſon, Ware, and Belchertown, preſent excellent illuſtrations of this poſition, as well as many towns between Shrewsbury range and Boſton.

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* Meſſrs. Danas mention porphyritic granite in a range of towns (Cambridge, Newton and Needham) from northeaſt to ſouthweſt, near Boſton. It is denominated porphyritic gneiſs in this work, and occurs in Weſtern, Litchfield Co. &c. See Geology of Boſton, page 80.

Ranges between Spencer and Northampton.

The gneiſs commences near the eaſt bounds of Brookfield, as we return to the weſtward along our ſection. It is difficult to fix on the weſt limits of this range. It appears to be the principal rock in all places, excepting the very loweſt, as far as the weſt bounds of Weſtern. Beyond that place, the higheſt hills are capped with hornblende rock; but gneiſs is the principal rock as far as Swift river. In the deepeſt valleys granite appears as far weſt as Belchertown, with the gneiſs between it and the hornblende rock. Near the Forge, one mile north of Belchertown meeting-houſe, is a ſtriking locality.

That part of this range, which lies between Chicapee river and Coy's hill, is porphyritic gneiſs.* It is curiouſly ſpotted with cubes and parallelopipeds of felſpar, of the granular variety. I have ſeen thouſands of theſe blocks from two to four inches long and from one to two inches wide. This variety of gneiſs runs ſoutherly through Brimfield; but it is not ſo broad as in Weſtern.

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* It is very extraordinary, that ſome American geologiſts *ſhould* denominate this rock porphyritic granite. Wherever it

The gneiſs of Brimfield, Sturbridge and Stafford contains in ſome places, large quantities of very ſoft ſulphuret of iron. This ſubſtance, when expoſed, is continually ſubject to chemical decompoſition; and ſulphate of iron is produced. Several chalybeate ſprings in Sturbridge owe their ſulphate of iron to this cauſe. The Stafford waters are well known. They alſo derive their chief qualities from the ſame ſource.

Near the boundary line between the towns of Sturbridge and Holland, there is a large bed

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occurs within the courſe of my obſervation, it is the moſt perfectly characterized gneiſs. In Weſtern, and in Litchfield county, Con. it is decidedly the uppermoſt layer of the gneiſs ſtratum. It is true, that the European books ſpeak of porphyritic granite; but they define true fine-grained granite. If they really meant this rock I could not ſervilely follow them againſt the indiſputable dictates of common ſenſe; notwithſtanding my high reſpect for ſome of their authors, borders on veneration.

of plumbago (carburet of iron) between extenſive layers of gneiſs, which was wrought many years ago. A ſhaft of 107 feet was ſunk here and many tons were taken out. In connexion with this is an extenſive bed of hornblende, not aggregated with any earthy ſubſtance; but arſeniate of cobalt is diſſeminated through it in ſmall quantities. It has no connexion with any hornblende rock; but is a mere inſulated homogeneous maſs.

In Brimfield the gneiſs contains very beautiful pearly adularia, ſometimes connected with ſmall cryſtals of zircon. Laminated plumbago is very frequently diſſeminated throughout extenſive rocks.

This range is not very extenſive near Connecticut river in Chatham and Haddam. In Haddam it is in vertical tables, where it is quarried to a great profit. Large quantities from this quarry are tranſported by water to Albany, Troy, and other river towns, to be uſed for flagging. The veins of granite, ſo rich in beautiful cryſtals of beryl, ſhorl, &c. traverſe the gneiſs of this quarry.

This range varies greatly in breadth on the north ſide of our ſection, as well as on the ſouth. Accompanying the Spencer range of granite into Canada, it ſtretches over four or five degrees of latitude with very little interruption. Col. Gibbs found beds of magnetic iron ore in it, in ſeveral places in New-Hampſhire. But like other ſtrata running through New-Hampſhire, as well as Vermont, it has not been duly examined far to the north.

This range evidently paſſes under Connecticut river, accompanying the granite and covered with other ſtrata, and riſes with it on the weſtern ſide. As far, however, as I have examined this range, it ſeems to be chiefly broken up into patches of little extent. Theſe patches are not unfrequent, and generally reſt immediately upon the granite.

Ranges between Northampton and Hinsdale.

To avoid being miſled by theory, has ever been an important conſideration with me, from the commencement of my geological reſearches. "Lead me not into temptation," ſhould be the prayer of every honeſt geologiſt. For theories are ſo faſcinating that perhaps none can effectually reſiſt them. With all my determination I cannot ſhut from my fancy that theoretic viſion, which preſents this gneiſs rock, commencing on the weſt ſide of the Northampton range of granite, accompanying and concealing the granite in one continuous ſtratum through to Hinſdale. Though it is itſelf covered with other ſtrata moſt of the way through Worthington and a part of Peru, I cannot but conſider it as the ſame ſtratum, preſenting its eaſtern and weſtern edges at Williamsburg and Hinſdale.

The eaſtern range conſtitutes moſt of that range of hills, or rather mountains, which runs through Goſhen, Cheſterfield, part of Williamsburg, Norwich, Montgomery, Ruſſel, Granville and Hartland. I have traced it in all theſe towns to my entire ſatisfaction; and I preſume the gneiſs near New-Hartford village belongs to this range. It ſeems to diſappear, or at leaſt to become rather uncertain, near the north bounds of Williamsburg and Goſhen. Moſt of this range has its layers conſiderably curved, and nearly in a vertical poſition, like all the other ranges of this ſtratum in New-England.

Several intereſting minerals have been diſcovered by Dr. David Hunt and Col. Gibbs in veins traverſing this rock. One new mineral, ſilicious ſpar,* is found in great abundance two miles northweſt from Cheſterfield village, alſo in Goſhen five or ſix miles further north. With the ſilicious ſpar of Cheſterfield is found beautiful green tourmaline and beryl. With that of Goſhen is found blue tourmaline, or indicolite, roſe and yellowiſh-green mica.

This range ſinks laterally under the upper ſtrata, and appears again a little to the eaſt of the higheſt part of the mountain of Peru. Almoſt the whole of this mountain is gneiſs. It extends northerly into Vermont, increaſing in breadth. It forms moſt of thoſe gigantic piles, which ſever the diviſions of the ſouth branch of the Deerfield river; and the higheſt part of the mountain eaſt of Adams, called Hooſack mountain. It is remarkably hard and harſh.

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* Soon after Dr. Hunt diſcovered this mineral, Col. Gibbs pronounced it a new one, or a new variety of felſpar. But Profeſſor Hauffman firſt analyzed it. It conſiſts of about 71 per cent ſilex, 20 alumine and 9 potaſh—ſometimes a very little lime, magneſia and iron. Felſpar contains from 12 to 14 per cent potaſh inſtead of ſoda. See Am. Jour. Science, page 348.

The poſition of its layers almoſt vertical, and often much undulated.

It maintains its breadth ſoutherly, ſpreading over a large portion of Litchfield county in Connecticut, as well as the northweſtern part of New-Haven county.

Range weſt of Hinsdale.

All the ſtrata between the Hinsdale range of granite and the argillite, are remarkable for their frequent alternations; or, perhaps more properly, their anomalous relations. I ſhall treat them, however, according to the order, which is ſo clearly preſented to us, every where to the eaſt of this range. But I ſhall not omit to notice all the local deviations from that order, which have fallen under my notice. Fortunately I have had a better opportunity to examine this part of our diſtrict than any other part; excepting the tranſition claſs in the ſtate of New-York. In addition to this advantage, I have had the aſſiſtance of that very able and accurate naturaliſt, Profeſſor Dewey of Williams College, for two or three years. He reſides at the very central point of the moſt complicated difficulties; and never ſuffers any intereſting fact to eſcape his notice.

This range of gneiſs is ſeparated into two layers, from near the ſouth boundary line of Maſſachuſetts far into the ſtate of Vermont, by a a broad layer of granular limeſtone connected with granular quartz. The layer next to the granite is thin; and at ſome places ſeems to be interrupted. It is generally low and reſts laterally againſt the granite. It paſſes ſuddenly under the very thin, though diſtinctly characterized, ſtratum of hornblende rock; over which lies the granular limeſtone.

The other layer, beyond the firſt range of granular limeſtone, forms the principal part of a range of high mountains. This layer of gneiſs, together with the mica-ſlate, talcoſe rock and granular quartz, conſtitute Saddle Mountain, twenty-four hundred feet* higher than the granular limeſtone, and ſeveral hundred feet higher than any mountain in Maſſachuſetts or Connecticut. This mountain range croſſes the ſtate of Maſſachuſetts and runs into Vermont. But it is cut down tranſverſely entirely to a level with the limeſtone at Williamstown and Pittsfield; and almoſt as low near Stockbridge.

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* See Profeſſor Dewey's Geology of Williamſtown, Am. Jour. Science, page 337.

Near the ſouth bounds of Maſſachuſetts, the eaſtern and weſtern ranges of granular limeſtone, which run along both baſes of this range of mountains, unite, and entirely inſulate it; or render it a peninſula.

Oppoſite to the ſouth end of this range of mountains, the layer next to the granite begins to extend in breadth, and ſoon becomes of conſiderable extent. Paſſing ſoutherly through the ſtate of Connecticut, it forms ſeveral lofty hills, which may be denominated mountains.

Mr. Brace has found plumbago in it and ſeveral other minerals common to this rock, in Litchfield county. In the peninſular part, three miles northweſterly from the village of Great-Barrington, I found a bed of oxyd of manganeſe combined with much oxyd of iron. Poſſibly this bed may be worth noticing; but I had no leiſure to purſue the enquiry. It is on M'Clure's Springfield ſection.

Ranges of Saratoga and the Highlands.

The gneiſs accompanying the Saratoga range of granite lies wholly on its weſtern ſide. For an explanation of this arrangement of the gneiſs, the reader is referred to the article on the granite of this range.

This is that variety, which is denominated, the moſt recent formation.* Its poſition is nearly horizontal, and its layers rarely undulated. In an analyſis of this range, we need not reſort to any train of reaſoning or analogy, to arrive at facts. For the river Hudſon having cut a tranſverſe ſection through it, ſeven or eight hundred feet in depth, we can examine all its layers, and its place of meeting with the granite, as we would inſpect a map.

Near the commencement of the gneiſs upon the granite, it dips a little to the weſt. But it is almoſt perfectly horizontal in the mountain Kayaderoſſeras which it conſtitutes about eight miles weſt of the granitic ridge. The extent of this range of horizontal gneiſs I have not been able to aſcertain. David Buel, Jun. Eſq. 2d Vice-Preſident of the Troy Lyceum, examined it about twenty-five miles weſt of its eaſtern edge;* and Major James Dalaby, the 1ſt Vice-

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* See the introduction to Dr. Steel's Analyſis of Mineral Waters.

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* Extract from a paper which was read by Judge Buel before the Lyceum:

"While on an excurſion through part of the counties of Schenectady and Montgomery, ſome obſervations were made on the Geology of theſe counties, in conformity with that duty which the deſign of our aſſociation impoſes on every member of the Lyceum.

"The tranſition claſs of rocks continues along the valley of the Mohawk nearly as far as the weſtern boundary line of the county of Schenectady.

"The argillaceous ſlate diſappears, by falling beneath the higher ſtrata, about eight miles from the city of Schenectady—corresponding very nearly with the geological map publiſhed by Dr. Steel of Saratoga. The rock under which the ſlate paſſes has the external appearance of the rubbleſtone variety of graywacke; but by teſting the rock with acids, it appears to conſiſt in part of carbonate of lime. It is here called baſtard limeſtone. In the courſe of two miles the rock ſtratum aſſumes the diſtinctive characteriſtics of the blue compact limeſtone. The traveller has now before him demonſtrative proof, that he has entered upon that ſecondary region, which continues many hundred miles to the weſt. This ſtratum, however, is of very limited extent to the *north of* the valley of the Mohawk.

Preſident, found that it extended to the Little Falls on the Mohawk, more than thirty miles farther weſt.* Dr. Steel has aſcertained that

"The ancient building of Sir William Johnſon, which is called Fort Johnſon, 32 miles weſt from Troy, is built of this ſtratum of compact limeſtone. And although it has been built about a century, the ſtones exhibit no marks of diſintegration.

"In going from Fort Johnſon to the village of Johnſtown, a diſtance of eight miles, we paſs obliquely over a belt of tranſition rocks, running nearly parallel to the Mohawk. About ſeven miles north of Johnſtown village the country is decidedly primitive. Here we fall in with that variety of *gneiſs rocks*, which ſome geologiſts conſider as of the moſt recent formation. They are made up of many diſtinct layers of which quartzoſe particles are in exceſs and their poſition is nearly horizontal. Theſe layers of gneiſs are probably a continuation of ſimilar rocks which form the baſis of the northweſtern part of Saratoga county.

"The village of Johnſtown reſts upon tranſition ſtrata; probably graywacke upon argillaceous ſlate; but the rocks are moſtly covered with alluvion. At Johnſton Hall, however, (which is three fourths of a mile from the village) the ſlate appears at the bed of a creek. This ſlate evidently reſts againſt the primitive rocks to the north."

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* Thoſe who have read Governor Dewitt Clinton's Diſcourſe before the New-York Literary and Philoſophical ſociety, in which he denominates the rock at the Little Falls granite, may conſider Major Dalaby's opinion as at variance with the Governor's. But it ſhould be noticed, that ſome geologiſts blend the granite and gneiſs ſtrata; on the principle, that there is no good reaſon for ſeparating them—their conſtituents being the ſame, and they frequently alternating with each other. But I cannot

it extends at leaſt eighty miles to the north. I have traverſed it in an oblique direction from Johnſtown in Montgomery country, to a place on Weſt Canada creek twenty four miles above its mouth; where I found that it correſponded in all its peculiarities, with the ſame rock at Hadley's Falls.

From ſpecimens which I have ſeen, collected in various parts of this range, and from my own examinations, I think, that a deſcription of this ſingular variety of gneiſs, taken at Hadley's Falls, will apply throughout.

Some layers of the gneiſs about Hadley's Falls, in Saratoga county, are remarkably well characterized. I found ſuch alternating with other layers of very peculiar character, from below the falls, to a mile up the river; and then from the banks of the river to the top of Kayaderoſſeras mountain. Moſt of the peculiar intervening layers conſiſt chiefly of fine

adopt this nomenclature; and as I have examined Major Dalaby's ſpecimens, and know them to be of the moſt recent formation of gneiſs, I adopt his name for the rocks at the Little Falls. His ſpecimens embrace calcareous ſandſtone, like the ſame rock at Hadley's Falls; and Gov. Clinton notices the ſame fact.

grains of quartz, rather looſely aggregated together. A few ſcales of mica are generally preſent and rarely a few grains of felſpar. Theſe layers haſten rapidly to a ſtate of diſintegration, forming a looſe ſandy ſoil. Such is the ſoil of much of the Jerſeyfield tract in Montgomery and Herkimer counties. Such a ſoil is remarkably warm ; but will devour much manure. In this immediate vicinity I diſcovered no deep alluvion ; though vaſt quantities of the ſandy kind muſt have been formed in ancient time. It has probably gone down the Hudſon and in other directions.

Another of theſe intermediate layers would be miſtaken for graywacke, without an attentive examination. Col. S. Young informed me, that before he had given much attention to geology, he miſtook a ſimilar variety at the Little Falls for greenſtone trap. I ſhould not be ſurpriſed if every young geologiſt ſhould fall into this error. For it is coloured much like it and preſents regular parallelopipeds. The moſt ſtriking ſpecimens of this laſt anomalous aggregate form the bed and low banks of the river, half a mile above Hadley's Falls. This ſometimes paſſes into calcareous ſandſtone, in which the limeſtone particles are in ſuch proportion, that it may be manufactured into indifferent lime. It often embraces very perfect rhomboidal cryſtals of carbonate of lime.

The moſt remarkable, and to me the moſt paradoxical, of all theſe intermediate layers, is the puddingſtone. A layer commences near the Falls, and extends up ſtream along the bank of the river half a mile. The conſtituent pebbles are all as much rounded, as the moſt perfect water-worn gravel ſtones. And the layer is overlayed as well as underlayed with well defined gneiſs. I do not mean that ſuch gneiſs is immediately in contact with the puddingſtone; but layers of it may be found in the bank above and below it. The pebbles conſtituting the puddingſtone are chiefly tranſlucent quartz, ſuch as we find in granite; cemented together by carbonate of lime and quartzoſe ſand.

I have never diſcovered many diſſeminated or imbedded minerals in this range. It contains conſiderable ſulphuret of iron of the ſoft granular variety; whoſe decompoſition, along the banks of the Hudſon near Hadley's Falls, forms conſiderable ſulphate of iron, or copperas water. The moſt important diſcovery, made in this range, is the ſulphate of barytes at the Little Falls on the Mohawk. Mr. Iſaac Briggs, while he was engineer for the great canal, preſented large ſpecimens of ſulphate of barytes to the Troy Lyceum, which he diſcovered at that place. It is the lamellar variety; ſome of a pearly white and ſome deeply coloured with red oxyd of iron. Whether it was embraced in the well characterized gneiſs, or in ſome of the anomalous layers, I have not been able to aſcertain.

The gneiſs on each ſide of the Highland range of granite is of the common, hard, vertical kind; reſembling the New-England ranges. As far as I have had an opportunity to examine, it preſented nothing peculiarly intereſting. But my inveſtigations here have been leſs minute and particular than at any of the localities deſcribed in this Index.

It is worthy of remark, that the rock ſtrata of the Highlands bear a relation to each other, more analogous to ſimilar rocks deſcribed by

European geologiſts, than in any other part of our diſtrict. Here the granite is generally the higheſt, while the gneiſs and other primitive rocks incline againſt its ſides. Whereas ſuch a locality can hardly be found in New-England. There the gneiſs is generally the higheſt.*

The gneiſs of the Highlands, as well as the granite, embraces magnetic iron ore, containing minute cryſtals of phoſphate of lime. Where this range paſſes through Pennſylvania, Mr. Conrad found melanite in it. But I found the ſame mineral in mica-ſlate in Conway, Maſs.

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* Dr. Ackerly has publiſhed a very ingenious profile view of the weſt bank of the Hudſon, through the Highlands, &c. But he informed me that he had not been minute in ſettling the limits of particular ſtrata. It is to be hoped he will find time ſoon to effect this very deſirable object.

STRATUM 3.

*HORNBLENDE ROCK.**

I HAVE adopted this general name for all rock aggregates of which hornblende is a conſtituent, excepting the ſuperincumbent claſs. This may be deemed an unauthoriſed innovation; but I am conſcious of no other motive in introducing it, than the want of any eſtabliſhed name, which has ever been applied as I find myſelf compelled now to apply this one. In the firſt edition I adopted the word ſienite. But I find this term has ſometimes been applied even to a variety of greenſtone trap. Primitive trap is completely embraced in this ſtratum, which I denominate hornblende rock; but it does not embrace *all*, which I think ought to be included in it; and I have adopted a deſcriptive name, which is ſufficiently comprehenſive. I will therefore detain the reader no longer with remarks upon the name; but will give my reaſon for uniting in one ſtratum, what has uſually been ſubdivided.*

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* Sometimes called ſienite, primitive trap, greenſtone porphyry, green porphyry, &c. See Meſſrs. Danas' Geology of Boſton and its vicinity.

My reaſon for uniting in one ſtratum all rock aggregates, containing a material portion of hornblende, excepting thoſe of the ſuperincumbent claſs, is a very ſimple one. It is becauſe nature has united every variety of this kind of rock, known in our diſtrict, in the ſame individual. When rocks are arranged geologically, no regard muſt be had to reſemblance or conſtituent elements in eſtabliſhing their order of ſucceſſion. All thoſe rocks which are labelled, in European collections, primitive trap, ſienite, porphyritic ſienite, greenſtone porphyry, green porphyry, and by various other names, provided they contain hornblende, and are not baſalt, amygdaloid or greenſtone trap, or maſses embraced in them, are found united in the ſame individual rock in many parts of New-

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* *M'Clure* repeats the words, Hornblende rocks, ſeveral times.

England. The ſtratum in which they are united generally reſts immediately on gneiſs; though ſometimes it alternates with it. This I denominate hornblende rock. All the porphyry, which I have found in place in New-England, is imbedded in this rock. The principal localities to which I would refer for proof of these aſsertions are, Framingham, Belchertown, Monſon, Worthington and Plainfield, Maſs.

In diſtricts of ſmall extent, the different varieties of this rock may well induce very accurate obſervers to give them different names. As Belchertown is on the great ſtage road from Albany to Boſton, it may accommodate a curious geologiſt the beſt to have minute directions for teſting my aſſertions applied to this place.

All the varieties, excepting that which is called primitive trap, will be found in the ſame ſtratum by commencing near the meetinghouſe and proceeding weſterly about two miles. Then, without loſing ſight of the ſame ſtratum, proceed towards a place in the ſame town nick-named the Dark Corner. On the right of the road a ſmall rocky eminence will appear, which is the primitive trap variety.

The other localities afford evidence equally ſtriking, more eſpecially that of Plainfield. But in tracing a continuous rock, we muſt frequently take many and various turns, leſt the alluvion and fields of other ſtrata miſlead us.

Some European geologiſts treat this as a ſubordinate rock. But its great extent and almoſt uniform preſence in its proper place, certainly entitle it to a place in a ſyſtem deſigned for our diſtrict.*

Ranges eaſt of Spencer.

Though the hornblende rock ſtratum is maniſeſt on both ſides of Worceſter and in place, it is very much broken and limited. Eaſt of the gneiſs rock, which terminates weſt of Framingham, this ſtratum is very extenſive. It is in fact, with all its varieties, the baſis rock almoſt to the Atlantic. Meſſrs. Danas have deſcribed it very minutely as it appears in the vicinity of Boſton, and illuſtrated it with a coloured map. They have ſubdivided it into common greenſtone, greenſtone porphyry, green porphyry, and ſienite. The reader may include porphyry as a ſubordinate or imbedded aggregate alſo, belonging to this ſtratum. But he ſhould be cautioned againſt confounding the rock, denominated common greenſtone by Meſſrs. Danas, with greenſtone trap of the ſuperincumbent claſs. Not having correſponded with theſe gentlemen, I do not preciſely underſtand by what ſyſtem they were governed in denominating the extenſive rock embracing Weſton and the towns north and weſt, common greenſtone. But they cannot in my opinion intend a rock reſembling the greenſtone hills about New-Haven; becauſe they are very different both in texture and geological relations. I take the New-Haven rocks for a ſtandard of reference; becauſe Col. Gibbs and Profeſſor Silliman, both of whom have ſeen European greenſtone hills in place, declare them to be perfect ſpecimens. Whereas the rock ſo denominated by Meſſers. Danas, is, according to my ſpecimens collected there, preciſely the ſame as that beautiful green variety of hornblende rock, which reſts upon gneiſs and frequently contains large veins of granite, in Belchertown. However, at the 42d page they ſeem to refer prehnite to the true greenſtone. I have no doubt but theſe gentlemen had correct views of their ſubject; but theſe remarks appeared neceſſary to prevent miſtakes. This range, like all ranges of this ſtratum, frequently contains epidote.

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* Dr. Lyman Foot ſuppoſes that hornblende rocks may be applied to great advantage in fortifications, on account of their being the tougheſt of all rocks.

Ranges west of Spencer.

The Belchertown range is more than five miles wide, and holds its breadth to a conſiderable diſtance north and ſouth. In Monſon, about a dozen miles ſouth, the ſlaty variety, being the primitive trap of Werner, is remarkably well characterized. It is this ſame range which contains the cobalt mines of Chatham, Con. But it ſeems to alternate with gneiſs at this mine. Arſeniate of cobalt is alſo found in this rock at Monſon in ſmall quantities. It contains epidote and actynolite in abundance in Belchertown.

It appears again, in interrupted fields and patches accompanying the gneiſs, on the weſt-ſide of Connecticut river. In a fragment of this range Dr. D. Hunt found arſeniate of cobalt alſo.

Between the Northampton and Hinſdale granite there are large quantities of this rock. It was long before I could comprehend the real poſition of this range of hornblende rock. But by frequent examinations, and by comparing its appearance on our ſection with that of the ſouth bank of Deerfield river, I came to this concluſion. That the high ridge of this rock, which croſſes our ſection weſt of the village of Worthington and runs northerly through Plainfield and Hawley to Deerfield river, extends laterally under the mica-ſlate and talcoſe rock both eaſt and weſt. That on the eaſtern ſide it appears again eaſt of the top of the mica-ſlate hill, which lies eaſt of Worthington village. That on the weſtern ſide it appears again on the [illegible]ſtern face of the high gneiſs mountain of Peru. The eaſtern wing, if I may ſo call it, appears in Conway in the form of the ſlaty variety. It appears alſo near Deerfield river. The weſtern wing alſo appears weſt of the town of Hawley, beyond the iron mines. Reference muſt be had to the drawing of our ſection to underſtand its poſition.

I think the varieties which this rock preſents in Plainfield, Hawley and Buckland, exceed all other localities within my knowledge. Here is the moſt beautiful porphyritic variety, the bright green, the dark chocolate, the ſlaty, the granular, &c. At Conway I found in it the petroſilicious porphyry, and in Hawley there are abundance of fine cryſtals of actynolite and of hornblende. In truth, there is more beauty in the ſtructure of the rocks of Hawley and Plainfield, than of any other place I have ever viſited.

On the weſt ſide of the Hinſdale range, this ſtratum is very limited. Yet it ſeems to be extended along without much interruption, in company with the firſt layer of gneiſs. Exactly againſt the village of Adams, twenty miles north of our ſection, I did not diſcover it in place. But a few miles ſouth, where the road croſſes the mountain towards Plainfield, it is diſtinctly manifeſt in place; though not of great extent. Wherever I have ſought for this range, I have not failed to find it in its proper connexion, throughout the ſtate of Connecticut. I once thought I had found it in place beyond the Saddle Mountain range as ſtated in the firſt edition of this Index. I can now account to myſelf for the deception; but it will be unintereſting to the reader. It evidently paſſes under the granular limeſtone and quartz, mentioned under the article gneiſs, never to riſe again in our diſtrict.

This ſtratum is very manifeſt at the Highlands. But I do not believe it overlays the horizontal gneiſs of the Saratoga range. It ſeems to have a place ſomewhere beneath it. Perhaps it is interpoſed between a lower ſtratum of gneiſs and the horizontal variety. It is very abundant in patches and large boulders in the excavated region between the Kayaderoſſeras Mountain and the granitic ridge. But I did not carefully trace it to its place.

STRATUM 4.

MICA-SLATE.

THIS ſtratum is very narrow or thin wherever it occurs in our diſtrict.* At leaſt I have never found it of great extent, uninterrupted. It is frequently found in patches or fields ſtrewed over a conſiderable tract of country. Being more ſubject to diſintegration than any of the three preceding ſtrata; whenever it is expoſed it ſoon becomes ſeparated into patches, diſcloſing the ſtrata beneath. But where it ſtill preſents its whole thickneſs, as in the banks of Deerfield river and at the Highlands, I have always found it very thin.

As it uniformly accompanies the preceding ſtrata and is rarely of much extent, or in continuous uninterrupted ranges, which are expoſed to view, I ſhall not deſcribe the ranges ſeparately.

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* Bakewell ſays, there is no well characterized mica-ſlate in England.

I found but very little mica-ſlate eaſt of Shrewsbury. Its proper place appears from analogy to be in the vicinity of Boſton; but Meſſrs. Danas found none there. I ſaw a few patches of badly characterized mica-ſlate between Shrewsbury and Framingham.

There is a little mica-ſlate in patches near Worceſter; and ſcarcely any more occurs along our ſection until we arrive at Belchertown. Here it appears capping the hills weſt of Swift river and throughout the town in looſe patches. But no where in place again until we come within a ſhort diſtance of the eaſt end of Mount Holyoke. Here it croſſes the ſtage road in place. By following this range north and ſouth, we actually ſee it paſſing over the hornblende rock ſtratum; clearly ſeparating it from thoſe higher ſtrata on which the greenſtone trap, conſtituting Mount Holyoke, repoſes. I mention this, becauſe ſome ſuperficial obſervers have conſidered them as united.

There is very little mica-ſlate near Northampton. But it is well-characterized and in place between Northampton and Hinſdale. It manifeſtly lies upon the hornblende rock nearly throughout the whole extent of what I before denominated the eaſtern and weſtern wings of the Worthington range. It is ſtill more apparent twenty miles north on the Deerfield river. It accompanies the gneiſs every where in Saddle Mountain and the other mountains in this chain. Here is no hornblende rock interpoſed between the gneiſs and mica-ſlate as in Belchertown and between Northampton and Hinſdale. The hornblende rock being in company with the layer of gneiſs, which reſts againſt the granite, it is not repeated here with this ſecond layer of gneiſs.

Staurotide and garnets are very common in mica-ſlate. The beſt locality is in Litchfield, Con. Profeſſor Silliman found elegant ſpecimens in Bolton. Dr. John Torrey found ſimilar ones on New-York iſland. I found beautiful ſpecimens in Chatham, Con. Mr. Silliman found cryſtals of pinite in Haddam. Profeſſor Dewey and myſelf found elegant acicular crystals of ſhorl in a wall near Williams College, which evidently originated near where we found it; and he has ſince found octahedral cryſtals of oxyd of iron. I found acicular cryſtals of ſhorl in this rock in Belchertown, Monſon and Litchfield.

There are ſeveral large maſſes of mica-ſlate in Cheſterfield, Maſs. which contain great quantities of ſappare, and garnets of an enormous ſize. In the ſame range, near the line between Conway and Deerfield, Mr. —— Hamilton of Conway conducted me to a locality of ſappare a few miles eaſt of the village. I found melanite in it near the ſame village in great abundance.

The mica-ſlate near Swift river in Belchertown and Greenwich, paſſes into that variety of which the coarſe ſcythe-whetſtones are made. In the Worceſter range this variety appears in ſmall quantities between Leiceſter and Worceſter, and in large quantities in Smithfield, R. I. In the range eaſt of Peru, where it paſſes through Middlefield, an extenſive quarry of this variety is ſaid to have been lately diſcovered. I have ſeen a ſpecimen of it, but have not viſited the place. Another locality of this variety is near Lenox. By diſintegration it forms ſand ſuitable for glaſs manufactories; and it has been applied with ſucceſs. Kirwan denominates this variety Stellſtein. It ſeems to be a talco-micaceous rock.

I have not been able to aſcertain a ſingle fact reſpecting the mica-ſlate, or other ſtrata, accompanying the Saratoga range of gneiſs; though I have made much enquiry. I preſume the gneiſs extends much farther to the weſt than the Weſt Canada creek; beyond which we have not explored. There is, however, a field of mica-ſlate two miles weſt of Saratoga Springs and a patch lying immediately on the granite near the ſouth extremity of the range, one mile northerly from the Springs.

STRATUM 5.

TALCOSE ROCK.

IN the firſt edition I applied the common name ſoapſtone to this ſtratum. But by the adviſe of Profeſſor Silliman, I have adopted this name. There is certainly great propriety in ſubſtituting this name; as it is intended to compriſe all rocks, in which talc is a material conſtituent. Such as common ſoapſtone, ſteatite, potſtone and that kind of ſhiſtoſe rock which is diſtinguiſhed from mica-ſlate merely by a kind of talc glazing. This laſt variety conſtitutes a part of Saddle Mountain and that ſhiſtoſe ridge which croſſes the ſtage road between Pittsfield and Dalton.

I ſaw ſeveral patches of this ſtratum lying upon mica-ſlate in Eaſt Sudbury. It was very coarſe and hard, containing but little talc. It appears in ſmall quantities on both ſides of Worceſter valley. As low down as Smithfield, R. I. it is conſiderably extenſive, and much used in the arts. There is a north and ſouth range of patches of this rock, in connexion with calcareous ſandſtone and granular quartz, paſſing one mile eaſt of Belchertown meeting-houſe, which I have traced for ſeveral miles. It is interrupted thence until we fall in with the mica-ſlate near Mount Holyoke. It appears in ſmall patches again on the weſt ſide of Connecticut river. In connexion with the mica-ſlate eaſt and weſt of the Worthington hornblende rock, it is more extenſive. In Middlefield it becomes a very extenſive quarry of ſoft ſoapſtone; and Mr. Emmons of that place has traced it to where it paſſes into beautiful ſerpentine. This is in the ſame range as the coarſer variety forming the eaſtern face of Snake Hill, between Worthington and Peru.

Juſt at the meeting of the mica-ſlate and the talcoſe rock,* where they paſs into each other, is the proper place for the ſpecular iron ore. Such is the ſituation of the Hawley mine, which has been wrought 20 or 30 years. The walls are moſtly a very white talcoſe rock, and black micaceous iron ore. The whole mine is included between two vertical rocks about four feet aſunder, running north and ſouth. The depth is unknown. This is the ſame range with Snake Hill and Middlefield quarry.

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* Bakewell ſpeaks of this talco-micaceous rock being common in Angleſea. P. 84.

Adjoining the mica-ſlate in Saddle Mountain, that variety of talcoſe rock which contains little more than a mere glazing of talc, is pretty extenſive. On aſcending to the Grey Lock from the Hopper* we paſs over it in the beſt place, perhaps, for collecting ſpecimens. Sixteen miles ſouth, where this vaſt mountain has dwindled down to a mere ridge of rock, nothing is left but this ſtratum. Where it approaches the ſtage road between Pittsfield and Dalton, it contains the ſmalleſt proportion of talc, which can entitle it to the appellation of talcoſe rock. But from a conſideration of its analogies, it muſt be placed in this ſtratum.

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* See Profeſſor Dewey's excellent eſſay on the Geology of Williamſtown in Am. Jour. Science, page 337.

This range is remarkable for its alternations with granular limeſtone. It extends ſoutherly through Maſſachuſetts, thence through Sheffield, Canaan, Salisbury, &c. Con. It alternates with the limeſtone three times in the towns of Salisbury and Canaan—the talcoſe, or talco-micaceous rock forming high hills, and the limeſtone the intervening valleys. It extends northerly far into Vermont. It forms a high mountain near Middlebury College,* and becomes of great extent ſtill higher north. Here it embraces moſt beautifully variegated ſerpentine of the common ſoft variety.

* It may be worthy of remark, that the ſerpentine, found in talcoſe rocks in our diſtrict, is always ſofter than that which is found in granite.

It will ſeem to be taking a bold, or rather viſionary, ground, to ſay that the ſtalactitic (hematitic) iron ore of Salisbury mine, was once ſpecular iron ore, imbedded in this range of talco-micaceous rock, ſimilar to that of Hawley, Maſs. But when the reader is informed, that the only rocks in the vicinity of the mines are of this kind, very ſimilar to thoſe in which the ſpecular ore of Hawley is imbedded, and that the alluvion embracing the ore in its preſent ſtate appears, by mere inſpection, to have proceeded from the diſintegration of a ſimilar rock, it will begin to appear ſomewhat plauſible. In addition to this, theſe iron ſtalactites are always pendent when laid bare before they are moved. They muſt therefore have been in a ſtate of fuſion as recently as the time when the alluvion was formed. And theſe ſtalactites are always ſuſpended from maſſes intermixed with the ſoil in ſuch a manner, that it is evident the iron was in a ſtate of fuſion when in contact with it. The ſoot, which ſtill adheres to all ſtalactitic ſpecimens, proves, that the heat was continued after the ore was confined in its preſent ſtate. If it was ever fuſed down from any rock, it muſt have been the ſame out of which the alluvion embracing it was formed. The cauſe producing ſuch a high heat I ſhall not attempt to aſſign. But that the ore exhibits ſufficient evidence of its having been recently fuſed, I believe no one can queſtion, who has ever inſpected it in place. I mean by recently, ſince all general ſtrata were completed, and during the era of alluvial depoſites.*

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* Dr. Edwin James.

Talcoſe rocks are found in place along both ſides of the Highland range. It is a principal rock at Hoboken and Staten Iſland near New-York; and appears to belong to, or incline towards, the granitic ridge of New-York Iſland. Dr. Bruce found pure magneſia (hydrate of magneſia) in this rock at Hoboken. Mr. Pierce found both hydrate and carbonate of magneſia on Staten Iſland in the ſame ſtratum.

In that variety of ſerpentine which is often connected with this ſtratum, Dr. Hayden diſcovered the chromate of iron near Baltimore, Md.

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* Extract from a letter, which I wrote to the correſponding ſecretary of the Troy Lyceum (Dr. A. Robbins) while I was acting as collecting agent, dated Litchfield, Nov. 17, 1818.

"The Salisbury ore-beds preſent materials for contemplation of the higheſt intereſt. That the ores are ſtrictly ſtalactitic cannot be queſtioned. But whence were the materials derived, and by what agent were thoſe materials brought into the liquid ſtate? By the elegant ſpecimens which I have collected for the Troy Lyceum, it will appear, that the ſtalactites are now actually covered with black velvety ſoot, and exhibit many other ſigns of having been expoſed to ſubſtances in the ſtate of combuſtion."

He repreſents this very intereſting locality of chrome as in a bare, bleak, ragged rock, unfit for the reſidence of any animated being, excepting thoſe of the moſt hated claſs. " If," ſays he, " a fratricidal Cain had here commit-
" ted his heaven-inſulting deed, we need not
" wonder; it bears ſo much the appearance of
" having experienced the unappeaſed wrath,
" the eternal curſe of an offended Deity. Scarce
" a ſolitary lizard, or a creeping ant is here
" ſeen, ſeeking among the mouldering ſerpen-
" tine a peaceful burrow in which to depoſite
" its daily ſpoils, and ſcreen its tender offſpring
" from the chilling blaſts of winter's wind,
" which ſweep in triumph over this dreary
" waſte."

STRATUM 6.

GRANULAR LIMESTONE.[*]

THIS ſtratum is very limited every where eaſt of Hinſdale; but weſt of that range it is one of the moſt intereſting of all the ſtrata.

Ranges eaſt of Hinſdale.

Meſſrs. Danas found granular limeſtone in connexion with argillite near Merrimack river, northweſt from Boſton. They treat it as a ſubordinate mineral. But it being in the ſame connexion as found in thouſands of acres near the weſt bounds of Maſſachuſetts, I ſhould be inclined to conſider their locality as a remaining patch of this broken down ſtratum. But as I never ſaw a fragment of it eaſt of Shrewsbury, I would merely propoſe this ſuggeſtion for the conſideration of Boſton geologiſts.

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[*] This is called cryſtalline limeſtone by Bakewell and others. In the firſt edition of this Index it was divided into granular limeſtone and quartz, calcareous and granular quartz, and metalliferous limeſtone. I am now ſatisfied that they all belong to the ſame ſtratum.

Fragments of this ſtratum are found along the Worceſter valley. And at Smithfield, 20 miles ſouth, as well as at Bolton, 12 miles north, it is found in quantities ſufficient to afford building quick lime for all the neighboring towns.

I have never diſcovered any granular limeſtone between the Spencer and Northampton ranges of granite; but I preſume it may be found. It is the higheſt ſtratum which occurs between the Northampton and Hinſdale granite; therefore the whole of this mountainous region is primitive. At Worthington the granular quartz, which always accompanies granular limeſtone, is abundant. And that variety of granular limeſtone, which is aggregated with conſiderable quartz,* is found here in place; though not in great quantities. I have traced this range to Deerfield river, about twenty miles north. Towards the weſt bounds of Hawley the proportion of carbonate of lime increaſes, and the ſtratum extends in breadth. But ſtill it contains a large proportion of quartz.

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* Bakewell ſays, that the granular limeſtone of Europe often contains a conſiderable quantity of ſilicious earth. P. 87.

In its whole extent it reſts immediately upon the talcoſe rock. And, though it is different from the granular limeſtone weſt of Hinſdale, it preciſely reſembles the latter in many localities, where it approaches the ſtrata above and below it. Therefore, ſince it is in the ſame geological connection as the upper, or moſt weſtern, diviſion of the Pittsfield granular limeſtone, it appears moſt convenient to conſider them as analogous ſtrata. To ſupport this analogy, we may conſider this Worthington range as reſembling the weſtern ſide of the Pittsfield ſtratum; but that it is not extended ſufficiently to preſent the pure limeſtone of the middle part of Pittsfield range.

There is a range of a ſimilar ſtratum repoſing on the talcoſe range eaſt of the Worthington and Plainfield high ridge of hornblende rock;

but it is not of much extent on our ſection. As far north as Conway, or even the north-weſt part of Williamsburg, it is conſiderably extenſive. It has here been manufactured into indifferent quicklime.

From a conſideration of theſe localities, I was induced to locate *all* granular limeſtone next above the talcoſe rock; which is the actual ſituation of the Pittsfield range. Though the alternations and ſubdiviſions of the weſtern granular limeſtone, which paſſes through Dalton and Pittsfield, afford but little concluſive evidence of its true place in a ſyſtem of geology, this arrangement comports better than any other with all phenomena relating to it and its connexions.

Ranges weſt of Hinſdale.

Limeſtone of this kind is conſidered by Bakewell and ſome other European geologiſts as a ſubordinate rock. But a vaſt ſtratum, extending from near Long Iſland to Canada, ought certainly to have a place among regular ſtrata. Beſides I have no doubt analogous rocks may be found in place, in every part of New-England; though they are leſs pure carbonate of lime, and of leſs extent.

I have traced this range from Reading in Connecticut through Bethel pariſh in Danbury, Brookfield, Waſhington, Cornwall and Canaan. Here it alternates three times with mountains of talco-micaceous rocks on the croſs road to Salisbury mines. And the main range running northerly, divides into two diſtinct branches, which continue ſeparate acroſs Maſſachuſetts and far into Vermont. The eaſt branch paſſes through Tyringham, Maſs. Waſhington, Dalton, Adams, &c. The weſt branch paſſes through Great-Barrington, Stockbridge, Richmond, Pittsfield, Lanesborough, Williamſtown, Pownal, Vt. Bennington, &c. It has been traced almoſt to Canada, by ſeveral correct obſervers. I have myſelf traced it into every town here named. When I was engaged in ſearching out the courſe of this remarkable ſtratum at the direction and expenſe of the Troy Lyceum, I was very anxious to follow the courſe of the weſtern valleys beyond Salisbury, before deſcribed; but I ſhould have exceeded my inſtructions. Whether they lead away weſterly to Hudſon river at the Barnagat lime-kilns, ſending off a branch to New-York Iſland, or return ſoon near the courſe of the principal range, I have not been able to determine. Dr. Akerly found granular limeſtone both in Dutcheſs and Weſtcheſter counties, very nearly in line between Salisbury and Barnagat, and between Waſhington and Kingsbridge.

All the branches of this ſtratum are accompanied by granular quartz rocks, moſtly of a yellowish hue. Near Williams College, the granular quartz forms the chief part of ſeveral mountains. There are two within three or four miles of the College, from twelve to fourteen hundred feet high.*

From the preceding enumeration of facts it appears, that this ſtratum alternates with all the primitive ſtrata, excepting granite and the hornblende rock. And I think I have ſome evidence of its alternating with the latter alſo.

Near the eaſt line of Danbury, Con. in the pariſh of Bethel, a creek cuts acroſs a ridge with perpendicular banks, about forty feet high. Here the granular limeſtone and gneiſs alternate with each other ſeveral times in ſucceſſion within a very ſhort diſtance. The limeſtone is perfectly white and extremely coarſe-grained. Here the layers dip to the weſt; but in Weſt Stockbridge and Alford they generally dip to the eaſt, though there ſeems to be no uniformity in their direction. Had ſome force, applied at the eaſtern edge, raiſed theſe mountain maſſes from the horizontal towards the vertical poſition, leaving ſome inclining to the eaſt and forcing others beyond a vertical poſition, they would have preſented their preſent inclinations.

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* See Dewey's Geology of Williamſtown.

This ſtratum is found in Pennſylvania and Maryland, (Conrad and Gilmor;) but I have received no information reſpecting its geological ſituation. The Milford marble is of this ſtratum; but to what range it belongs, or whether it is inſulated and independent, I am not able to determine; though I examined its geological ſituation with that view. It appears to be, *geographically*, in the courſe of the range croſſing our ſection at Worthington; but it reſembles the Pittsfield range.

There is frequently conſiderable proportion of carbonate of magneſia combined with the carbonate of lime, forming Dolomite throughout all the extent of this range from Pittsfield, Maſs.* to Reading, Con. Tremolite is frequently found in it; and in Canaan, Con. it is very abundant. In Brookfield, Con. I discovered a new locality of pyroxene, or white augite, in this rock. It is very abundant about half a mile west of Brookfield village. Sometimes it contains asbeſtos, ſerpentine,† iron, pyrites, &c. Dr. Meade diſcovered that ſlabs of this rock, when wrought out pretty thin, are often elaſtic.

In Alford, and ſeveral other places, it contains mica and talc. Here, (Alford,) I found it frequently paſſing into preciſely the ſame variety as that mentioned in Hawley, belonging to the Worthington range.

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* Since writing the above I received a letter from Profeſſor Dewey, dated April 7, 1820, in which he informs me, that he has found Dolomite in abundance in this range north of Williams College, near the ſouth bounds of Vermont.

† It contains ſerpentine, forming verde-antique, alſo in Scotland.—*Bakewell.*

The moſt durable marble is manufactured from this ſtratum, throughout moſt of its extent. This is the genuine ſtatuary marble. There is no doubt, but it may be quarried in almoſt every part of the range; though the appellation, Stockbridge marble, is given to the whole. The New-York City Hall is built of this rock. In ſome parts it abounds in iron pyrites, which is injurious to the marble. But it is generally a pure white, or a little motled with light blue; and free from all metallic ores.

Weſt of Pittsfield, near the eaſtern boundary line of the ſtate of New-York, it paſſes under the vaſt ſtratum of argillite. Fortunately here is no room for conjecture. By mere inſpection we actually ſee the granular limeſtone paſs under the argillite for at leaſt twenty miles in extent from north to ſouth. Along the ſtage road weſt of Pittsfield, the limeſtone is united with a conſiderable proportion of quartzoſe particles or ſand; ſo that it reſembles the variety which generally prevails to the eaſt of Hinſdale. It is often blackened on its ſurface by the decompoſition of ſulphuret of iron, near the argillite.

II. TRANSITION CLASS.

STRATUM 7.

ARGILLITE.

THIS ſtratum is rather limitted wherever it appears in New-England. But in the ſtate of New-York it forms the baſis rock of more than two thouſand ſquare miles.

In Profeſſor Silliman's notice of the firſt edition of this Index, he ſays; that the clay-ſlate of Woodbridge hills near New-Haven, is primitive, that of Rhode-Iſland with anthracite is tranſition, and that near Middletown, Con. with impreſſions of fiſh is ſecondary. Therefore he infers that, by confining argillite to the tranſition claſs the ſcience may be embarraſſed.[*] Such a ſuggeſtion made by one of my principal inſtructors in Mineralogy and Geology, would naturally induce me to ſearch dilligently and decide with caution. Having found myſelf compelled, by a review of facts, to yield my opinion to his, reſpecting the ſuppoſed range of metalliferous limeſtone in Maſſachuſetts ; I was prepared to yield alſo in the caſe of the argillite. But after the moſt diligent ſearch and reviews, I think I have the beſt of reaſons for leaving the ſtratum of argillite excluſively in the tranſition claſs.

All the primitive, which has come to my knowledge, was manifeſtly in beds in granite, gneiſs or mica-ſlate. And even theſe beds are very limitted. The Preſident of the Troy Lyceum, the Hon. John D. Dickinſon, Eſq. brought home very perfect ſpecimens from near Lake Champlain, which he found imbedded in granite. The bed was of very little extent. Dr. Edwin James found ſimilar beds in ſeveral localities in Vermont. In truth I have not been able to aſcertain a locality of the primitive ſlate, which was not manifeſtly a bed, or a ſubordinate rock.

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[*] See American Journal of Science, page 70.

With reſpect to the ſecondary argillite, this has always been found in very limitted beds in our diſtrict. That which contains the fibrous ſulphate of barytes in Schoharie county is certainly a mere bed, and very different in texture from either primitive or tranſition argillite. It may rather be denominated argillaceous graywacke than argillite.

Perhaps the queſtion may be asked, how ſhall we determine whether it is a bed or a ſtratum? The ſame queſtion may be asked reſpecting ſerpentine, dolomite, &c. I treat every rock as ſubordinate, which is wholly embraced in other rocks when in place; and which never appears independent and continuous in large diſtricts. Bakewell ſays, p. 98: "If all "the varieties of rock found among the pri- "mary* were arranged in diſtinct orders, the "the number would be indefinitely extended,

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* I think this remark applies with equal force to the tranſition, and in ſome meaſure to the ſecondary.

"and the ſcience encumbered with a liſt of "names which would be of little uſe.— "It is, I conceive, better to claſs theſe varieties "under one head as *Anomalous*, and to de- "ſcribe their peculiarities whenever they oc- "cur."

Now this ſame variety of argillite, which I consider as tranſition, is the baſis rock throughout ſeveral counties in the ſtate of New-York. It appears in ſeveral limitted ranges in New-England, and always in the ſame geological connexion, when clearly aſcertained in place.

The next queſtion is, why ſhould it be placed in the tranſition claſs,* if it be admitted, that there is but one kind of ſufficient extent to form a ſtratum, and that it is always found in the ſame geological connexions? The anſwer is a ſimple one. It is the loweſt rock in our diſtrict containing organic relics, theſe are always of marine origin; and it reſts immediately upon granular limeſtone, which is the higheſt primitive ſtratum.

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* Bakewell obſerves, p. 101: "Geologiſts have been frequent- "ly perplexed in attempting to determine whether certain rocks "belonged to the tranſition claſs. The uncertainty aroſe princi- "pally from placing argillaceous ſchiſtus in the claſs of primary "rocks." At page 102, he adds: "That ſlate which lies neareſt "the primary rocks has a more ſhining luſtre than the other, and "partakes more of the cryſtalline quality of mica-ſlate. As this "recedes from the primary, it more frequently contains organic "*mpreſſions*."

Organic relics are extremely rare in this ſtratum; but it is ſo remarkably continuous and uniform, that a ſingle ſpecimen in it, if well aſcertained, is ſufficient proof. Dr. Edwin James found ſeveral *anomites* and *pectinites* in the very ſame ſtratum which paſſes under this city, (Troy,) where it approaches Lake Champlain. The very perfect ſpecimen of *orthocerite*, which was dug out of the rock at the north end of this city is concluſive. This fact is perfectly guarded againſt the poſſibility of miſtake. It was inſpected in place by Dr. Wells, Dr. Hale, and ſeveral other members of the Lyceum. I have frequently ſeen the rock from which it was taken. It was diſcovered while cutting a ſtreet through a ſolid rock of argillite about four feet below its ſurface. This ſame rock may be traced unbroken throughout more than two thouſand ſquare miles. It embraces a large proportion of the counties of Saratoga, Schenectady, Albany, Renſſelaer and Columbia. It extends into the weſt margin of Maſſachuſetts, and there reſts immediately on the granular limeſtone.

Ranges east of Hinsdale.

When I was engaged in ſearching into the geology of the vicinity of Boſton, I was induced to believe that this ſtratum exiſted under the deep alluvion, principally from the large patches and fragments which I found there. For when a ſtratum of a ſoft rock is not near, we never find even boulders or patches of it. We find large blocks of granite, gneiſs and hornblende rock in the vicinity of Troy, thirty or forty miles out of place. But we never find mica-ſlate or talcoſe rock. I have obſerved the ſame fact in Blenheim, Delhi, and other towns in Delaware and Schoharie counties. Hence when I find large fragments of a ſoft rock, I infer that it is not far out of place. Beſides, the graywacke commonly accompanies argillite, and overlays it. Therefore I had good reaſon to receive the preſence of graywacke, as evidence of the proximity of a ſtratum of argillite.

Meſſrs. Danas have confirmed this opinion by an extenſive courſe of obſervations.*

A little weſt of the village of Worceſter this ſtratum appears of conſiderable breadth. And it increaſes in breadth both to the north and ſouth. Pretty large quarries are now wrought in Smithfield, R. I. to the ſouth, and in Bolton to the north.

The Connecticut river range is conſiderably extenſive in Vermont; but as it runs ſoutherly it deſcends beneath the other ſtrata, and entirely diſappears in Greenfield. It probably paſſes beneath the graywacke, as this becomes a pretty extenſive rock a few miles ſouth of Northampton.

Mr. Hitchcock calls the Connecticut river argillite, primitive. In this he is governed by European deſcriptions of hand ſpecimens. But ſpecimens anſwering to their definitions of roof, and primitive, ſlate, may be found here, and every where elſe in our diſtrict, within a few feet of each other in the ſame individual rock.

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* See he Geology of Boſton and its vicinity, page 101.

The primitive argillite brought to the Troy Lyceum by Mr. Dickinſon from the weſt part of Vermont, is totally different from any I have ſeen from Connecticut river, from Boſton or from any part of the vaſt range in the ſtate of New-York; though ſpecimens may be ſelected, which accord with the letter of the definition. Since the argillite on Connecticut river,* at Worceſter and Boſton, is in the ſame geological poſition as that in which organic relics are found, and does not eſſentially differ from it in ſtructure, I have thought proper to conſider them as analagous ſtrata.

We now paſs over the interval between Northampton and Hinſdale, as it is wholly primitive.

Range west of Hinsdale.

I cannot fix the northern or ſouthern limits of this range. It has been traced from Vermont through the counties of Waſhington, Renſſelaer and Columbia into Dutcheſs. Near Poughkeepſie it winds weſterly, croſſing the Hudſon into Ulſter county. From the ſouthern part of Columbia county to about as far north as Albany, a diſtance of about 50 miles, it is chiefly embraced between Hudſon's river and the Maſſachuſetts line—a breadth of about 20 miles. Some diſtance below Albany, near Kinderhook landing, it extends acroſs the river, and ſpreads out gradually to the weſt as it advances northerly; ſo that it embraces a large portion of that part of the counties of Schenectady and Saratoga which is ſituated neareſt to the river.

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* I have been informed by an intelligent young gentleman, who has reſided twenty years near Bellows Falls, Vt. that much of the argillite in that vicinity preſents highly inclined laminae, and in all reſpects reſembles that variety of argillite in Renſſelaer county, which contains organic relics; though he never ſaw any relics in it on Connecticut river.

It is remarkable, that in almoſt every part of this range the laminae are nearly vertical, or inclining a little towards the weſt or northweſt. Not having been able hitherto to adopt any tenable theory reſpecting this phenomenon, I will give Bakewell's. He ſays, page 103, "This rock is always repreſented as ſtratified; "but in this reſpect it reſembles gneiſs and mi-"ca-ſlate, and the ſlaty and tabular ſtructure "are, I conceive, the effect of cryſtallization, "depending on the nature of the conſtituent

" parts. In the ſlate rock at Charnwood Foreſt the ſlaty laminae make an angle of ſixty " degrees with the principal ſeam by which " the rock is divided." Whether this is the true cauſe of this arrangement of the laminae or not, it is intereſting to know, that a ſimilar ſtructure has been obſerved beyond the Atlantic. The dividing ſeams forming a large angle with the laminae are manifeſt in many localities; particularly along the banks of the Mohawk near the Cohoes Falls.

In ſome parts of this range the laminae are curved, at others ſtrait, in others irregularly fiſſile and readily ſhivered into lenticular or formleſs fragments. Where the laminae are ſtrait, this ſtratum is quarried and manufactured into roof ſlate. One quarry has long been wrought near the north bounds of Dutcheſs county and one in Renſſelaer. There is another locality not wrought where nature has opened the quarry, on the bank of Stony Brook in Chatham, Col. county, on the land of Major Eleazer Cady.

The curved or undulating kind may be found in various parts of the range. It is very abundant towards the eaſt bounds of the town of

Chatham. The irregularly fiſſile variety abounds near Troy and Albany. In the cleavages of this variety the fragments are frequently gloſſed over with carburet of iron. This glazing or gloſs is very common near Cohoes bridge, at the Canal between Troy and Lanſingburgh, at Greenbuſh and a little ſouth of Albany.*

Near Maſſachuſetts line weſt of Weſt Stockbridge, the argillite paſſes into chlorite ſlate. Here too the veins of milky and greaſy quartz embrace large maſſes of pure chlorite. This variety of ſlate, as well as the veins of quartz containing chlorite, are found in almoſt every part of the whole range; but more particularly near its eaſtern edge. Adjoining the chlorite ſlate it is often curiouſly variegated in colour. We find it deep red, brick-colour, purple, bluiſh purple, and deep blue. All theſe colours may be found in travelling along the turnpike road from Weſt Stockbridge meetinghouſe towards Hudſon, within four miles of the ſtate line. The beſt locality is along the deſcent of the hill, eaſt of the place nick-named Pilferſhire.

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* This is the variety, which has deceived ſo many European colliers, as well as ſcientific geologiſts. The appearance very nearly reſembles bituminous ſhale, which accompanies coal. This has induced much fruitleſs ſearch for it. Several hundred dollars have been expended in digging into this rock. It remained for the members of the Troy Lyceum to detect the deception; and at their requeſt Profeſſor Silliman analyzed this gloſſing, and found it to be very hard carburet of iron.

Two or three miles weſt of Williams College, where this range paſſes along northerly, I found large quantities of graphic ſlate or drawing ſlate, in connexion with both chlorite, and talcoſe argillite.

Sinople jaſper is found in various parts of the range. I have ſeen it in Columbia, Renſſelaer, Albany, Schenectady, and Saratoga, counties. A ſtudent at Williams College found one ſpecimen of beautiful ſtriped jaſper. Several ſpecimens have alſo been found in the vicinity of Troy; and one large ſpecimen of the moſt beautiful graſs-green.

Cubic maſſes of iron pyrites are common in every part of the range; ſometimes an inch in diameter. Copper pyrites is found in the varniſhed variety, at the canal between Troy and Lanſingburgh. A ſingular variety of fibrous or ſtriated quartz is very abundant in the ſeams of the varniſhed variety of argillite in the vicinity of Troy. Below where Buel's graywacke quarry reſts on this rock, in the banks of Wynant's Kill, this variety of quartz may be found in veins many feet in breadth, from one to two inches in thickness, and ten or twelve inches in length—calculating the length in the direction of the ſtriae. I carried ſpecimens to New-Haven, and on comparing it found no ſuch variety in the great cabinet of Gibbs.

At New-Lebanon Springs and in Pownal, Vt. near the houſe of Mr. Hall, the argillite paſſes into alum-ſlate. The expoſed parts, at the laſt locality, become perfect alum, or at leaſt there is no ſenſible difference between the alum of commerce and that manufactured in this workſhop of nature.

Several ſprings highly charged with ſulphuretted hydrogen iſſue from the varniſhed variety of argillite near Troy and Albany. Griſcom analyzed one ſpring near the manſion of George Tibbits, Eſq. in Troy and pronounced it a genuine hepatic ſpring. There is one ſpring in Greenbuſh, oppoſite to Albany, and another a little below the city of Albany, ſo ſtrongly charged with ſulphuretted hydrogen, that a piece of ſilver coin becomes tarniſhed in a few ſeconds after being dipped in it.

Moſt geologiſts, as Phillips, Jameſon and others, follow Werner in making a diſtinct ſtratum of ſilicious ſlate or tranſition flinty ſlate. But I follow Bakewell in conſidering the argillaceous, and ſilicious ſlate as paſſing into each other. He ſays, the flinty ſlate "appears to "differ from common ſlate by containing a "greater proportion of ſilicious earth." I have good authority for doing this, within half a mile of the Troy Lyceum. For the ſhore between the upper and lower Ferries oppoſite to Troy, is a naked rock of diſtinctly characterized argillite and ſilicious ſlate, paſſing into each other ſeveral times in ſucceſſion. Laſt Spring (1819) I conducted Profeſſor Mitchell and Dr. Akerly to this locality. Both of theſe diſtinguiſhed geologiſts conſidered it as concluſive evidence, that the flinty ſlate ought not to be geologically ſeparated from the argillite. Phillips ſays, p. 134, the "flinty ſlate "is of ſmall importance; it principally occurs "in Bohemia, and in the lead hills in Scotland." And I do not remember that the indefatigable Bakewell gives any new locality. Perhaps it is more extenſive in our diſtrict, than in any other hitherto explored. I have found it towards the weſtern part of our range of argillite all the way from Schenectady county to Dutcheſs. The city of Hudſon is moſtly built upon alluvion, which evidently reſts upon flinty ſlate. The hill or bluff adjoining the river Hudſon, is a naked rock of this kind. The baſis of Mount Marino, ſouth of South Bay, is flinty ſlate; though it is capped with graywacke. Near the ſouth end of the Cauſeway is a remarkable locality of Lydian ſtone, or Baſanite, in the ſame rock. Specimens of it are alſo found in the vicinity of Troy.

There is a vaſt rock half a mile eaſt of Lanſingburgh called Diamond Rock. All its fiſſures or cleavages are lined with cryſtals of quartz; and moſt of its ſurface is ſprinkled over with them. It conſiſts of coarſe grains of quartz aggregated together; but totally unlike true granular quartz. For the grains of the granular quartz have but little luſtre, and are moſtly opaque and of a dull white or of a yellowiſh hue. Whereas the grains of this maſs are tranſlucent, and have a glaſſy luſtre ſo as to preſent a conſiderable degree of brilliancy. As ſoon as geology had awakened a ſpirit of enquiry in this vicinity, this rock became a ſubject of conſiderable ſpeculation. But it was ere long diſcovered, that looſe maſſes of a ſimilar rock were ſpread over every part of this ſlate-rock diſtrict. Though none were found ſo large as Diamond Rock; they were very common of many tons weight, and thence down to the moſt minute pebbles. Whence were derived ſuch quantities of a ſimilar rock, ſpread over two thouſand ſquare miles of territory? Was there ever ſuch a ſtratum overlaying the argillite? Theſe enquiries were repeatedly made; but no ſolution was attempted. A few other aggregated maſſes were obſerved by my pupils in this part of our diſtrict, which I could refer to no aſſignable place in the ſyſtems of geology; and they all ſeemed too extenſive to treat as accidental aggregates. But as ſoon as the thought occurred, that the vaſt extent of naked argillite in the neighborhood of the Cohoes Falls on the Mohawk, might preſent ſomething tending to obviate the difficulty, all ſpeculation ceaſed. If the lofty banks of the Mohawk are examined from the Falls down towards the Hudſon a few miles, the ſame aggregate will occur in ſcores, embraced between the laminae of argillite. It requires no train of deduction to prove, that, when the ſoft argillite paſſes away by diſintegration, thoſe ſilicious maſſes will endure and remain in the alluvion.

I found, in the ſame ſituation, all the anomalous aggregates, common to this ſlaty territory. Blocks of calcareous ſandſtone, ſpecimens reſembling metalliferous limeſtone, calcareous ſpar, and various other ſtones, are here embraced; but never paſs into the argillite nor preſent any characters indicating any relation to it.

I have dwelt ſo long upon this ſubject, becauſe theſe facts may tend to elucidate analogous phenomena in regard to other ſtrata, as well as thoſe which relate to this vaſt range of argillite.

Argillite contains veins of milky quartz in England, according to Bakewell;* and near

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* Page 240 and 241.

Waſhitaw Hot Springs, according to Schoolcraft.* I have already noticed the ſame fact in our diſtrict. I may add, that thoſe large maſſes, which ſo frequently occur in the counties of Columbia, Renſſelaer, Saratoga, &c. were evidently left by the argillite, after it had become diſintegrated. There is a remarkable maſs more than one hundred feet in diameter, in the town of Chatham, Columbia county, on the eaſt ſide of Indian Brook, near Starkweather's tannery. It conſiſts of amorphous milky quartz, with hexahedral cryſtals diſſeminated throughout the whole maſs. I have broken off cryſtals three inches in diameter. But the larger cryſtals are not ſo tranſparent as the ſmaller. Both terminal pyramids are very perfect on quartz cryſtals in argillite near Albany and Troy. Mr. William Yates preſented one to the Troy Lyceum, ſix inches long and three inches in diameter, with both terminal pyramids, which he found near Troy. Dr. Low found the moſt perfect, large, limpid cryſtal I ever ſaw, in argillite at Greenbuſh.

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* Page 183.

STRATUM 8.

METALLIFEROUS LIMESTONE.

AFTER it had been demonſtrated, that the weſtern diviſion of the granular limeſtone, paſsing through Pittsfield, was not the metalliferous ſtratum, as it united with the eaſtern or Dalton diviſion in Canaan, Con. it ſeemed to be admitted that there was no ſuch ſtratum in our diſtrict. But as ſoon as Dr. Edwin James, a member of the Troy* Lyceum, had taken his geological excurſion from Albany to Canada, a different opinion began to obtain among geologiſts. He diſcovered a ſtratum of carbonate of lime, which he traced from near Ticonderoga to Burlington, below the red ſandſtone and above the argillite. And as he diſcovered no graywacke beneath it or eaſt of it, and ſaw ſome evidence of its exiſtence as a ſtratum immediately above it; he concluded that this lime ſtratum was between the graywacke and argillite.* At any rate, he aſcertained the fact of its being interpoſed between red ſandſtone and argillite; and that it was too extenſive and independent for an imbedded maſs. In addition to this, he found it contained organic relics; of courſe it could not be the primitive ſtratum.† From

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* This is its poſition in Brocken Mountain, Germany.—Phillips, p. 114.

† Extract from a paper read before the Troy Lyceum, by Dr. Edwin James.

" The bed and both ſhores of Lake Champlain, St. John's river, and the iſland of Montreal are tranſition and ſecondary.

" At Ticonderoga the rock is granite, with gneiſs and ſienite inclining againſt its eaſtern and weſtern ſides. The compact limeſtone, forming the baſis rock of Montreal iſland, the ſhores and iſlands of St. John's and Champlain, abounds in organic relics and maſſes of hornſtone. Frequently it conſiſts in part of ſilicious ſand. The largeſt proportion of the organic remains is made up of *anomites*. *Pectinites* are next in quantity; *orthocerites* and *ammonites* are not uncommon. *Corallinites* (by ſome conſidered as a ſpecies of ſea-weed) are occaſionally found here. At Crown Point the relics are not ſo abundant. Here the limeſtone has been cut through in conſtructing the fort, and it is found to reſt on breccia. Beneath the breccia is the red ſandſtone, which here contains relics probably of *corallinites*, though in one inſtance I diſcovered univalve *moluſcae*. Sometimes this ſtratum paſſes into a kind of variegated ſandſtone, or ſomething reſemthe ſpecimens which he preſented to the Troy Lyceum, it is manifeſt that it does not

bling granular quartz. All theſe rocks hold nearly a horizontal poſition.

“ A range of hills runs along the eaſt ſide of the lake from about five miles eaſt of Ticonderoga through Burlington, &c. which conſiſts of red ſandſtone, paſſing into a light coloured ſandſtone upwards. It frequently riſes to the height of one thouſand feet above the ſurface of the lake. Beneath the ſtratum of red ſandſtone, and perhaps below where the ſandſtone paſſes into graywacke, is a ſtratum of limeſtone reſting on argillaceous ſlate. I am inclined to conſider this ſtratum as the true *tranſition* or *metalliferous* limeſtone, notwithſtanding its exiſtence in North America has been queſtioned. Its texture is intermediate between the granular and the compact ſtrata. Being below the ſandſtone it cannot be the compact or ſecondary ſtratum ; and as it certainly contains organic relics, it cannot be the granular. I venture, therefore, to conſider it as the ſame ſtratum with that in which the ſilver mines of South America are imbedded.

“ The argillaceous ſlate, upon which the tranſition limeſtone reſts, contains argillaceous iron ore, calcareous ſpar, ſulphuret of iron, and, in one inſtance, I found *corallinites* embraced in it.

“ In the vicinity of Middlebury College, I have not been able to trace the arrangement of the ſtrata with much ſatisfaction to myſelf; though I examined them more attentively here than at any other place. The country is decidedly primitive, conſiſting of granular quartz, granular limeſtone, mica-ſlate, talcoſe rocks, &c. In addition to the common difficulties attending geological reſearches made in primitive countries, here ſeems to be a kind of interference among ſeveral croſs ranges. The Green Mountain range ought to be attentively and minutely examined by an experienced geologiſt, who has leiſure to compare the various appearances on an enlarged view of the whole chain.”

belong to the compact or ſecondary limeſtone. It appears to be intermediate between granular and compact, or rather approaching the granular, in its character or texture. We will anticipate ſo far as to inform the reader, that the compact limeſtone is always above (never below) the red ſandſtone, where both are preſent, in our diſtrict.

G. R. Davis, Eſq. a member of the Troy Lyceum, has diſcovered a pretty extenſive ſtratum of limeſtone in Hooſack, Renſſelaer county, interpoſed between the graywacke and argillite. Its texture is alſo intermediate between the primitive and ſecondary. It is preciſely in the true geological and geographical locality to be a continuation of the ſtratum obſerved by Dr. James. I have frequently obſerved a range of limeſtone paſſing through New-Lebanon, Canaan, &c. in Columbia county, of a texture much more compact than the granular ſtratum. But I conſidered it as a continuation of the Pittsfield range of primitive; paſſing under the hill of argillite weſt of Pittsfield, and appearing again at this place. I may, however, have been *biaſſed* by theory ſo far, as to be convinced without ſufficient examination.[*] Perhaps this range may appear to be a continuation of that which has been obſerved by Dr. James and Mr. Davis; as it is preciſely where it ſhould be, if it is extended in a manner analogous to other ſtrata.[†] It is hoped that ſome of the members of the Hudſon Aſſociation of Naturaliſts, will extend their zeal to the inveſtigation of this ſubject. For the preſent I ſhall conſider it as alternating with argillite in this place.[‡] Dr. Akerly diſcovered the ores of lead, copper and zinc in limeſtone in the town of Amenia in Dutcheſs county. It is very probable this is the true metalliferous limeſtone. It would be doing the ſcience a favor, if ſome geologiſt near that locality would trace it ſo far as to diſcover its geological relations.

The great ſilver mines of Potoſi in South America are in this ſtratum. We have a ſpecimen of it in the Troy Lyceum. Wherever limeſtone is found containing ores, if it is not compact, we may ſuſpect it to belong to this ſtratum. I have never found any ore, excepting iron pyrites, in granular limeſtone.

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[*] Bakewell ſays, p. 135, "It is always deſirable, but perhaps "not always eaſy, to keep the deſcription of facts diſtinct "from the language of theory. With this limitation theo"ries have their uſe, not only as they aſſiſt the memory in con"necting inſulated facts, but alſo as they induce us to examine "nature, in order to prove the truth or fallacy of the ſyſtem "which we may be inclined to form or" controvert.

This ſtratum ſeems never to have been ſought by geologiſts in New-England. Excepting in the Connecticut river range, which paſſes down to New-Haven, and ſome limited patches in the vicinity of Boſton, there exiſt no rocks which, from analogy, ſhould be expected to accompany metalliferous limeſtone in our ſection.

Mr. Schoolcraft found metalliferous limeſtone in Miſſouri;* but he did not particularly aſcertain its geological connexions. I. M'Conihe, Eſq. found limeſtone, which appears to be of that ſtratum in ſeveral of the weſtern ſtates. M'Clure mentions beds of this rock running through Pennſylvania, &c. of a blue, grey, red and white colour, in company with graywacke ſlate.†

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* See Schoolcraft's View of Miſſouri mines, p. 195.

† See his Obſervations on the Geology of the U. States, p. 43.

STRATUM 9.

GRAYWACKE.[*]

NEXT to the compact limeſtone the graywacke is the moſt extenſive ſtratum in North America. According to M'Clure it appears, that it commences in the Miſſiſippi Territory and continues unbroken to Lake Champlain at leaſt, and perhaps into Canada. It forms ſome of the principal ranges of the Allegany, and all the Catskill, mountains. In our own diſtrict it forms the baſis rock of more than ten thouſand ſquare miles.

Ranges eaſt of Hinſdale.

I found ſeveral patches of well characterized graywacke ſlate along the valley of Worceſter,

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[*] Sometimes erroneouſly ſpelt greywacke, as though it were a compound of the Engliſh word grey.

The largeſt which I ſaw was near the ſtage road eaſt of the village.

Meſſrs. Danas found the rubbleſtone variety of graywacke in conſiderable quantities near Boſton, as appears by their deſcription. But they ſay no ſtratification of graywacke has been obſerved there. I certainly ſaw pretty large looſe maſſes lying about Bunker's hill, when I was there, of the fineſt ſlaty variety. I have a ſpecimen of it now before me. I ſaw none in place; but from thoſe fragments I ſuſpected its place might be found in that vicinity.

There is a pretty extenſive locality of graywacke ſlate ſouth of Northampton, alternating with red ſandſtone. It is a very common ſtone in the ſide-walks at Northampton. I have ſeen it where it conſtitutes a ſmall hill, at the outlet of Salſtonſtall's pond at Eaſt-Haven. Alſo in a pretty extenſive field between the Milford marble quarry and the village of Milford. It is greeniſh and might be taken for greenſtone trap by an inexperienced obſerver. I do not know what range to claſs it with, as I before ſaid of the Milford marble. It is however a very limited ſtratum in New-England. So are all tranſition and ſecondary rocks, excepting red ſandſtone.

Range weſt of Hinſdale.

I will now return to the proper region of graywacke. It reclines immediately on the argillite along the whole length of the weſt bounds of Maſſachuſetts. But it is either cut off together with the argillite by the valley of New-Lebanon, or both ſtrata alternate with the metalliferous limeſtone. In the tranſverſe ſection I have adopted the latter opinion; leaving any neceſſary alterations to future enquiry. Though the graywacke is ſcarcely interrupted for ſo great an extent along the line of Maſſachuſetts, it is interrupted by frequent valleys throughout the counties of Columbia and Renſſelaer. In truth it merely caps the hills of argillite, excepting in a very few localities, until it paſſes more than half acroſs the county of Columbia, and entirely acroſs the county of Renſſelaer.

A little weſt of Maſſachuſetts line, directly upon the turnpike road leading from Weſt-

Stockbridge meetinghouſe to Hudſon, is a locality demonſtrating the graywacke (rubbleſtone) and graywacke ſlate to be the ſame rock. Here the graywacke ſlate is as perfect as in any part of the Catskill Mountain, paſſing into the coarseſt and moſt perfect rubbleſtone; all in the ſame individual rock. This rock is of ſeveral miles extent north and ſouth, and the rubbleſtone is the upper part of it throughout. Theſe two varieties are ſimilarly ſituated towards the top of Catskill Mountain.

The rubbleſtone variety is the hardeſt and moſt durable. In every part of the counties of Columbia, Renſſelaer and Greene, rounded maſſes of rubbleſtone, from a foot in diameter down to an inch, are ſtrewed over the fields and along the highways, to the great annoyance of the agriculturaliſt and traveller.

The graywacke becomes the principal baſis rock near Hudſon river; though its commencement is in a zigzag line. Near the weſt line of Chatham on the Hartford and Albany turnpike, in Claverack on the Union Turnpike, and near Albany, there are extenſive localities of that brittle variety of graywacke, which Dr.

Mitchill calls brittle ſlate.* The locality in Claverack meets a field of the compact limeſtone in a very abrupt manner. Soon after croſſing the river Hudſon we enter upon the vaſt territory of perfect graywacke.† Though

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* See Bruce's Journal, p. 1.

† Extract from a paper read before the Troy Lyceum, by Dr. I. M. Wells.

"That part of the county of Albany, which is ſituated near the Hudſon, between the city of Albany and Bethlehem, preſents very little to intereſt the geologiſt; excepting the part which immediately adjoins the bank of the river: being moſtly ſo deeply buried in the proper alluvion, it is difficult to aſcertain the baſis rock.

"From Bethlehem, twelve miles ſouthweſterly from Albany, nearly to Durham in Greene county, the loweſt rocks in view are graywacke; while moſt of the hills and high ridges are terminated upwards by compact limeſtone. This upper ſtratum ſeems to conſiſt wholly of organic relics, cemented together by the ſame in a further ſtate of diſintegration. The ſame ſpecies of organic remains prevail throughout this diſtrict, which are found moſt abundant in this ſtratum in every part of the ſtate. *Anomites* and *pectinites* probably conſtitute nine tenths of the whole. *Terebratulites* and *gryphites* (two of the varieties of anomites) are very abundant. A cornute variety of *madreporite*, *encrinites*, *entrochites*, *celleporites*, *reteporites*, *orthocerites*, and *cornu-ammonites* are often found.

"There are ſeveral vaſt ſpurs extending weſterly from the Catskill Mountains, between Durham Peak and the ſouth bounds of Ulſter and Sullivan counties. There is a remarkable uniformity other ſtrata reſt upon it, we diſcover nothing beneath it in a weſterly direction in the ſtate of New-York; and probably not much eaſt of the Rocky Mountain at the head of the Miſſouri. It forms the valleys and the baſes of all the mountains and hills, for one hundred and thirty miles in a weſterly direction. About thirty-five miles beyond the Suſquehanna river, we

in all theſe ſpurs, ſo far as reſpects their geological ſtructure. The foundation is always graywacke, and the higher ſtrata are red ſandſtone and breccia. In ſome places there appears to be the remaining veſtiges of compact limeſtone.

"Large boulders of primitive rocks are frequently found here; though not a primitive rock exiſts *in place* nearer than the Highlands. They are chiefly gneiſs and ſienite, ſometimes granular quartz, and rarely granite.

"Petrifactions abound in all the great ſpurs of the Catskill, both in the graywacke and red ſandſtone. I procured ſpecimens of *pectinites*, *gryphites*, and *terebratulites*, near Batavia kill. The inhabitants report that they procure petrified butterflies on the top of a very high mountain, about ten miles from this place. Theſe are probably *trilobites;* becauſe this ſpecies of relics is uſually called the butterfly, or miller, by the common people.

"The ſoil upon and between theſe mountain ſpurs is juſt as a theoretical geologiſt would conjecture. The graywacke furniſhes the ſilicious and argillaceous materials. Where it approaches the ſoft argillaceous variety, the ſoil it furniſhes is of courſe the clayey kind. Where the rock paſſes into the quartzoſe variety, it gives a ſandy ſoil. In many places the debris of the lately diſintegrated lime ſtratum is very manifeſt."

fall in with conſiderable compact limeſtone, under which the graywacke and the red ſandſtone begin partially to diſappear.

A deſcription of the eaſt face of Catskill Mountain, will be a pretty correct deſcription of the whole of this graywacke region. Beginning at the village of Catskill, we meet with a hill of compact bluiſh graywacke near Benton's bridge, which a careleſs obſerver might miſtake for greenſtone trap. Proceeding along upon the little Delaware turnpike to the Catskill mountain, we find the graywacke uninterrupted; though it is covered with a field of compact limeſtone for about two miles. On aſcending the mountain we paſs over all the varieties of this ſtratum. The eaſt face of the mountain is made up of the perpendicular terminations of horizontal layers, arranged like a flight of ſteps. This arrangement has induced many of thoſe geologiſts, who prefer reading in a cloſet to an examination of the productions of nature, to denominate this the trap formation. This is however an excellent name for a ſuperficial geologiſt; for it is ſo vague in its application, that it may be made to mean almoſt any rock.

Some of the layers are hard, coarſe and rough; others are ſo very ſoft that during ſeveral years reſidence here, I miſtook them for argillite. After aſcending about eight hundred feet, we fall in with a layer of red ſandſtone. From this place the graywacke and red ſandſtone alternate with each other four or five times in about one thouſand feet. There are two lakes on the mountain, which are ſituated in a depreſſion in it, through which the turnpike road was wrought. On aſcending about one hundred feet either to the north or ſouth, the red ſandſtone, ſupporting the breccia, becomes general.

I traverſed the weſtern ſpurs of this mountain, taking a ſurvey with chain and compaſs for about ſixty miles weſterly, taking three ſeparate nearly parallel routes, about twelve miles aſunder. I found the ſame alternations of red ſandſtone among the upper layers of graywacke, every where. The rubbleſtone variety occurred frequently; but was not univerſal.

If nature would preſent all her rocks ſo naked to our view as the graywacke, &c. of this portion of our diſtrict, we ſhould no longer have occaſion for nice enquiry. The wild waters of the mad Schoharie, have laid bare a deep winding channel in this range for fifty miles. The Delaware and the Suſquehanna have alſo waſhed the flat ſurfaces and perpendicular edges of the ſame rocks more than one hundred miles.

The fine-grit and the coarſe-grit grindſtones, preciſely the ſame varieties as thoſe which are imported from Nova Scotia, are found in vaſt quantities imbedded in this rock, both in Catskill and Blenheim.*

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* Extract from a paper which I read before the Troy Lyceum.

At the time when the Troy Lyceum authoriſed me to make an excurſion through the eaſtern part of this ſtate and into New-England, at the expenſe of this ſociety, to collect geological facts and geological and mineralogical ſpecimens, his honor John Lanſing, Jr. L. L. D. late chancellor of this ſtate, very emphatically expreſſed his approbation of this new mode of improving natural ſcience. He then aſſured me, that he would, at his individual expenſe, cauſe a geological ſurvey to be taken of the country to a conſiderable diſtance on the weſt ſide of the Hudſon, whenever I could conveniently attend to it. Accordingly I ſet out on the propoſed expedition on the 15th of laſt May, (1819) and returned on the 30th. During ſeveral days I was accompanied by the Chancellor, in perſon, and profited much by his reflections upon the various occurrences which appertained to the object of our reſearches.

In the ſide of a ledge of graywacke at a plaee called Bear's Ladder in Blenheim, near the weſt bank of Schoharie kill, I obſerved a ſeries

It would be as difficult as unintereſting to diſcriminate, in this eſſay, between the obſervations of the Chancellor and of myſelf, made during the excurſion. Though our opinions were often at variance, we reviewed, reconſidered and diſcuſſed, until we agreed on all material points.

The diſtrict of country which fell immediately under review, embraced a large proportion of the counties of Schoharie, Greene and Delaware, and a ſmall part of the county of Albany. The baſis rock between the rivers Hudſon and Suſquehanna is graywacke; and from ſpecimens received, and former obſervations, I am authoriſed to ſtate that the ſame ſtratum continues thirty or forty miles ſtill farther weſt. Towards its upper ſurface this rock abounds in organic relics, which are moſtly *pectinites* and *anomites*. We found ſome *oſtracites*, one *concha-venerite*, (as named by Le Sueur) and ſeveral other rare ſpecimens.

We found no organic relics far below the ſurface of the graywacke. I believe they are rarely found at a great depth in this rock. In truth I have never ſeen *any* relics far below the ſurface of this rock, excepting an *orthocerite*, which was dug out of the argillaceous ſlate rock at the north end of this city. But Dr. Edwin James found petrifactions of bivalve ſhells in what he conſidered as the argillaceous ſlate and tranſition lime rock near lake Champlain.

Imbedded in the graywacke there are vaſt layers of ſandſtone, of very different colours and textures. Some are coarſe, being preciſely the ſame aggregate as that from which the Nova Scotia grindſtones are taken. Some are fine grained, and ſimilar to the fine-grit grindſtones uſed by carpenters. Some are even ſo fine that excellent hones for razors are manufactured from them of globular maſſes of well characterized graywacke, each three feet in diameter. They are compoſed of concentric ſpheres, one within another; and are ſet in firmly between two hori-

Along the bank of Schoharie kill, in the town of Blenheim, runs an extenſive layer of ſandſtone, of a peculiar kind. It conſiſts of fine particles of quartz, moſtly cemented together by carbonate of lime and a little alumine, and is ſpotted with dots of red oxyd of iron. Three miles weſt there is a ſimilar layer, ſeveral hundred feet higher. The latter has been wrought into very beautiful building ſtone; ſpecimens of which may be ſeen in the facings of ſeveral buildings in Albany.

On aſcending the mountains, we always fell in with red ſandſtone; and the higheſt mountains are often capped with breccia. This arrangement of ſtrata is remarkably uniform throughout a diſtrict of country about one hundred and thirty miles from eaſt to weſt, and, with a few exceptions, the extent is about the ſame from north to ſouth. The red ſandſtone always alternates ſeveral times with the uppermoſt layers of graywacke before it becomes uniform. Towards the tops of ſome of the higheſt hills, we meet with breccia, reſting on the different layers of red ſandſtone. I have often seen the breccia reſting on the red ſandſtone and graywacke, forming thoſe vaſt horizontal ſteps in Catskill Mountains, many hundred feet below other ſteps which were alſo compoſed of graywacke, red ſandſtone and breccia. Though I never traced the breccia ſo as to ſee that it was overlaid by the graywacke or red ſandſtone; yet from a haſty view, theſe three ſtrata ſeem to alternate with each other. At any rate, the red ſandſtone and graywacke certainly do alternate in every part of the diſtrict; which forms a ſtrong argument in favor of Bakewell's opinion, that the red ſandſtone ought to be placed in the tranſition claſs.

zontal layers of graywacke, like cheeſes ſet vertically between the ſhelves of a pantry. All of them happen to be broken through their centres; ſo that they preſent their concentric layers as diſtinctly as an onion cut through tranſverſely.

The red ſandſtone throughout the whole of this vaſt diſtrict, contains that kind of organic relics, which is denominated *kalmiite* in the geological Index. From the reflections of Dr. P. S. Townſend, and from further examination, I am now inclined to conſider it as a ſpecies of the genus *eriſmatolite* of Martin. As this genus is wholly of marine origin, all evidence that this ſtratum belongs to the ſecondary claſs ſeems to be removed.

Large boulders and blocks of compact ſhell limeſtone are found in various parts of this diſtrict. Theſe are manifeſtly the remains of a broken down ſtratum, which once extended over a vaſt territory. In the vicinity of Hudſon, Catskill, and some other places, extenſive fields of this ſtratum ſtill remain. Theſe maſſes ſeem to have ſlidden down from above the graywacke to a lower level, and often to have become concealed beneath the more recent alluvial depoſites. The remaining monuments, which indicate the former exiſtence and diſintegration of the lime ſtratum, are numerous. The vertical cleavages of the graywacke are frequently lined with calcareous ſpar, or with perfect cryſtals of carbonate of lime. The perpendicular ledges are often faced with calcareous tufa, evidently diſſolved and depoſited by carbonated waters which have long ſince ceaſed to flow.

Throughout the town of Blenheim we find ſcattered blocks of gneiſs and ſienite, ſimilar to thoſe found among the weſtern ſpurs of Catskill Mountains, by Dr. Wells, and thoſe which are ſo *abundantly* ſtrewed over the counties of Albany and Schoharie.

Towards the top of a mountain nearly oppoſite to the laſt locality on the eaſt ſide of Schoharie kill, about eight hundred feet above it, there is a horizontal layer of graywacke, which is pierced in all directions with holes reſembling thoſe in amygdaloid. The next layer above it contains *corallinites*. On comparing them I am inclined to believe, that the holes were cauſed by the decompoſition of the animals under ſuch circumſtances as to leave the ſpaces occupied by them empty.

While I am on the ſubject of *corallinites* I would aſk, whether thoſe arboreſcent white

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The neareſt primitive diſtricts, from which theſe blocks could have originated, are the Highlands, and the range eaſt of Pittsfield, in Maſſachuſetts; the former about eighty, and the latter about ſeventy, miles diſtant, in a right line. Perhaps an accurate compariſon of ſpecimens might aid us in tracing theſe blocks back to their parent ſtrata, and eventually lead to many intereſting reflections. A fragment of about one foot by two, conſiſting of ſerpentine, containing greeniſh calcareous ſpar, beautifully cryſtallized and traverſed by the amianthus variety of asbeſtos, was found near the northeaſt corner of Blenheim. Iron Pyrites and talc are diſſeminated through the ſerpentine. I never ſaw a ſpecimen of this aggregate in the eaſtern range of primitive rocks; but it is very abundant in the Highlands. Therefore, until more facts are collected, I ſhould be inclined to refer this maſs to the latter range.

ſtripes, ſo common on the upper layers of graywacke, may not be the obſcure petrifactions of corallinites? I am aware that ſtripes, much reſembling them, are very frequent in granular quartz, which is evidently primitive. And that it may be ſaid we ought to preſume that the ſame cauſe produced theſe appearances in both. But I have ſeen ſeveral ſpecimens in graywacke, where thoſe ſtreaks were diſtinct cylinders eaſily broken out entire.

European books ſay, that graywacke paſſes into argillaceous ſlate. I adopted this opinion in the firſt edition of this Index, and was thereby greatly miſled. There is a manifeſt diſtinction between rocks paſſing into, and alternating with, each other. After the moſt accurate examination of which I am capable, I diſcover no evidence of this fact. Near Troy are ſeveral remarkable localities, preſenting the two ſtrata diſtinctly at the place of their meeting. I find many layers of graywacke ſlate which are ſofter than any argillite. There is one locality near Schoharie kill about half a mile ſoutheaſt of the manſion of Jacob Southerland, Eſq. of Blenheim; and another in Carliſle, *Schoharie* county, containing the blue fibrou ſulphate of barytes. But in all theſe, the preſence of thoſe glimmering ſcales of talc forms a deciſive characteriſtic. Though this variety is chiefly an argillaceous ſubſtance, in which there is more alumine than in argillite itſelf; yet its geological relations are very different, and it may always be diſtinguiſhed in hand ſpecimens by the ſhining ſcales. I have no doubt this is the ſoft argillite ſo frequently noticed in Indiana, &c. by Mr. D. Thomas.

This ſoft variety of argillaceous graywacke contains blue fibrous ſulphate of ſtrontian in Pennſylvania, according to Seybert.* But it is probably the ſame variety of ſulphate of barytes above deſcribed; for this new variety deceived Cooper, Mitchill, Townſend, Low and ſeveral others, as well as myſelf; while we relied on its external characters. But an analyſis readily detected the miſtake.

The moſt beautiful large ſized cubes of iron pyrites are found in graywacke ſlate and rubbleſtone. I have obſerved that it is moſt abundant in the loweſt layers, or neareſt to the argillite. In the pariſh of New Concord, Columbia county, the radiated variety is very abundant. Mr. A. Cady preſented a ſpecimen from there to the Troy Lyceum, about two inches in diameter, which is a moſt perfect oblate ſpheroid. Anthracite, or glance coal, is found at Schuyler's quarry, and ſeveral other places in graywacke near Troy.

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* See Cleaveland's Mineralogy, p. 127.

Graywacke is conſiderably metalliferous, but its ores are generally in the layers neareſt to the argillite. The ſulphuret of lead in Livingſton's manor is ſaid to be found in the upper layers of the argillite and in the lower layers of graywacke. The late Dr. Livingſton of Hudſon preſented to the Troy Lyceum ſpecimens of ſulphuret of lead, contained in well characterized graywacke. This he found in place in the Manor, ſix miles eaſt of Hudſon River, and about the ſame diſtance weſt of the principal mine. The Rev. F. C. Schaeffer found ſulphuret of ſilver and ſulphate of barytes with the Manor lead.

In Blenheim on the ſouth ſide of the Suſquehanna turnpike road near the 43 mile ſtone is an extenſive bed in graywacke of a ſubſtance, conſiſting of carburet of iron, black oxyd of manganeſe and red and black oxyd of iron. The ſame ſubſtance is found in Renſſelaer county and in Hillsdale in Columbia county, all in the ſame variety of graywacke.

I have in my poſſeſſion a ſpecimen of graywacke ſlate, which contains ſhort cryſtals of ſapphire. It was picked up on New-York Iſland by Dr. John Torrey about five years ago; but, being thrown among unaſſorted minerals, was not noticed until lately. As there is not a known locality of ſapphire in North America, it will be well to make further ſearch among the graywacke.

The upper layers of the graywacke contain numerous organic relics. They are moſtly the remains of extinct ſpecies of animals. Bakewell ſays the remains found in tranſition rocks "may be regarded as ancient records, imprinted with the natural hiſtory of the firſt inhabitants of the globe. We learn from the organic remains and impreſſions which theſe rocks contain, that zoophytes and ſhell-fiſh, which are conſidered as forming the loweſt link in the ſcale of animal creation, were the firſt that received the gift of life."

Graywacke, like argillite, does not contain petrifactions in every part of any range. I have ſearched for them in vain for many miles. Then I have found immenſe quantities of them in the very ſame rock, which, for a great extent, did not preſent a fragment. In Blenheim I procured for the Troy Lyceum abundance of *pectinites* and *anomites*, alſo a few *mytilites* and one *venerite*. *Trilobites* abound in the graywacke near Hudſon. It is a remarkable fact, that the metallic ſubſtances are moſtly confined to the lower, and the organic relics to the upper, layers of graywacke. The rubbleſtone variety, which is generally among the uppermoſt layers, contains the moſt relics in the looſe fragments along the Schoharie kill in Blenheim, a little northerly from the manſion of Mr. Southerland.

As the graywacke abounds in ſulphuret of iron, hepatic and chalybeate ſprings are not uncommon in it. From a haſty analyſis, made in the open field, of the waters of a ſpring three fourths of a mile north of the toll-gate at the forty-third mile ſtone on the Suſquehanna turnpike in Blenheim, I inferred that they were ſtrongly charged with ſulphate of iron and ſlightly with ſulphuretted and carburetted hydrogen. Infuſion of galls gives dark purple in two minutes; nitrate of mercury firſt gives a grey cloud then precipitates a black powder; nitrate of ſilver gives a red colour in half a minute, which becomes darkiſh purple in five minutes. Neither barytic water nor oxalate of ammonia produces any change. The odour is that of ſulphuretted and carburetted hydrogen. On drinking half a pint of the water I felt a ſenſation of dryneſs in the mouth and throat. A diſagreeable ſenſation in the ſtomach and pain in the head enſued. It is uſed by thoſe who reſide in this vicinity, as a cathartic, and as an anti-ſcorbutic waſh. It iſſues from a cleavage in the graywacke rock 50 feet below the top of the ledge.

I have detained the reader with a more particular deſcription of this ſpring, than comports with the plan of this Index. But as ſprings, in their ſenſible qualities reſembling this, frequently occur in this graywacke region, this may ſerve for a general deſcription of the whole.

STRATUM 10.

RED SANDSTONE.

THIS is the old red ſandſtone of Werner, which he places in the ſecondary claſs; but Bakewell places it in the tranſition claſs. I have given my reaſons for following Bakewell in the Grammar of Geology. M'Clure was inclined to place it here after taking a moſt extenſive view of the geology of the United States;* and I have no doubt but every American geologiſt will finally adopt his opinion.

I expected to ſee ſome pretty large patches of red ſandſtone ſet down on the geological map of Meſſrs. Danas; becauſe I ſaw looſe fragments of it in the vicinity of Boſton, particularſy about Charleſtown. But they did not discover any, which they deemed worthy of a place in their treatiſe.

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* See American Journal of Science, p. 212.

In the Connecticut river range, the red ſandſtone is pretty extenſive. It alternates with graywacke below Northampton, as in Catskill Mountains. I have traced it from Greenfield, Maſs. to New-Haven. It follows the courſe of Connecticut river as low as Middletown. The river inclines to the eaſt, cutting its way through the primitive rocks, from that place; leaving the red ſandſtone to continue its courſe to Long-Iſland Sound. It is ſeveral miles in breadth all its way acroſs the ſtate of Connecticut. It paſſes under and ſupports a range of greenſtone trap hills from Deerfield to New-Haven. Weſt of Hartford it paſſes under the greenſtone ridge and appears again in the banks of Farmington river; and it holds this breadth in the narroweſt part, in a ſouthern direction to the Sound.

Returning to the ſtate of New-York, we find it a very important ſtratum. The range on Hudſon's river below the Highlands at Tappan bay, is well known; but I have no knowledge of its having been traced to any conſiderable diſtance northerly, or northeaſterly. Dr. Akerly has traced it along under the greenſtone trap from below Haverſtraw to Fort Lee, thence through moſt of the ſtate of New-Jerſey.*

As was obſerved under the deſcription of the graywacke, it alternates with the upper layers of that ſtratum all the way from the eaſt face of Catskill Mountain to about thirty five miles beyond the Suſquehanna. At a place two miles north of Durham ſtreet, Greene county, the red ſandſtone deſcends even to the bottom of a valley; but it is generally confined to the higheſt elevations. There are ſeveral fields of it, which appear as though they had been undermined by the diſintegration of their ſupporting graywacke and tumbled down many hundred feet. There is one hill of this deſcription of the brittle ſlaty kind, a little north of the manſion of John Livingſton, Eſq. nearly oppoſite to Catskill; another a few miles eaſt of Kinderhook; another of great extent about a mile northeaſterly from the reſidence of Neri Stoddard, Eſq. in Cairo, Greene county.

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* See the Geology of the Hudſon River, by Dr. S Akerly

The layers which alternate with the graywacke are always harder than thoſe above, where the red ſandſtone becomes uniform. There is a mountain in Blenheim, called Mineral Hill, which is almoſt wholly red ſandſtone for ſeveral hundred feet in thickneſs. This is of about as ſoft a texture as that of the Tappan range; conſequently may be denominated red freeſtone.

It is remarkable, that where the graywacke dips beneath the upper ſtrata, the red ſandſtone diſappears with it, or in a very ſmall diſtance. But both theſe ſtrata ſeem to be laid bare at intervals very far to the weſt, in the compact limeſtone region. Mr. M'Conihe ſaw it in Indiana in ſome deep ravines and ledges, and Mr. Schoolcraft ſaw it in the banks of the Miſſiſippi. At the bottom of the Niagara Falls it appears, alternating with the brittle ſlaty variety of graywacke, as in Catskill Mountains.* It appears alſo along the ſhores of Lake Ontario, of Oſwego river, &c.

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* See Dr. Mitchill's appendix to the New-York edition of Cuvier's Theory of the Earth, p. 352. The arrangement of rocks at theſe Falls demonſtrates the importance of conſidering ſtrata on a large ſcale. Becauſe from this local view it would appear, that this variety of friable graywacke held its place in the ſyſtem next to compact limeſtone, and above red ſandſtone. Whereas

Bakewell ſays, page 112, that coal is never found below red ſandſtone, and that metals are never found above it in the *form of veins*. I do not know, that theſe declarations have been corroborated by reſearches made in our diſtrict.

A peculiar kind of organized remains is very common in the red ſandſtone of our diſtrict. The beſt localities, to which I can refer the reader, are, at the Mineral Hill in Blenheim, and one mile ſouth of the upper lake on Catskill Mountain, about one mile eaſt of Edwards' ſawmill at the outlet of the lower lake. Theſe relics require particular notice.

Jameſon, in his notes to Cuvier,* ſays; "The red ſandſtone contains but few petrifac-

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any one, who climbs the numerous mountains of Greene, Schoharie and Delaware, will learn, that the upper layers of the graywacke always alternate ſeveral times with red ſandſtone before we come to the compact limeſtone. And that ſometimes the friable variety of graywacke will happen to be uppermoſt next to the limeſtone. I have ſeen two ſuch localities in Columbia county. One at Becraft's Mountain, and one in Claverack.

* *See* New-York edition of Cuvier's Theory of the Earth, *page* 221.

"tions, and theſe are principally of trunks or "branches of trees, ſome of which appear to "reſemble thoſe of tropical regions." I adopted this opinion on my firſt examination of theſe relics. The roots of the kalmia latifolia (common laurel) are of the cloſeſt texture and fineſt grain, perhaps, of any fruteſcent plant in the northern latitudes. Pieces of theſe petrifactions ſeveral feet in length may be ſeen in great quantities at both theſe localities, which preſent a ſtriking reſemblance to the roots of this ſhrub. But on tracing ſeveral ſpecimens to their natural terminations, they appear to end like the terete poſterior extremity of the common earthworm, or angling worm. I depoſited a very perfect ſpecimen of this deſcription in the Troy Lyceum. After a very attentive review of thouſands of theſe petrifactions, I am convinced that their prototype was not any ſpecies of plant with which I am acquainted; and I am inclined to refer them to the tribe of naked vermes; notwithſtanding they preſent arboreſcent plant-like appearances. I ſay naked, becauſe there is not a particle of carbonate of lime embraced in them. But they are perfect ſubſtitutions of ſandſtone, though much finer grained than the *encloſing* rock. They are from one inch in diameter to the ſize of a ſmall gooſequill. I have traced ſome of them ten or twelve feet in a ſerpentine courſe, without finding a natural termination, and ſometimes without diſcovering much difference in the diameter. Their texture ſometimes appears a little fibrous, and often preſents the appearance of concentric layers. Though their natural form is terete, they are often much compreſſed.

They are not confined to the plane of the layers of the encloſing rock; but often penetrate it obliquely. Several branches originate from a thick ſtock in ſome ſpecimens like roots from the bottom of a ſtump.

Not many ores have been diſcovered in the red ſandſtone of our diſtrict. Antimonial copper ore was found in it near Hartford, Con. by M'Clure; and both the red oxyd and carbonate of copper in New-Jerſey by Gibbs.

Many profitable quarries of this ſtratum are wrought in our diſtrict. That at Tappan on Hudſon's river and at Chatham on Connecticut river are among the beſt. Many others might be wrought which are overlooked, in various parts of the ſtate of New-York.

III. SECONDARY CLASS.

*Introductory Remarks from Bakewell.**

" AS there are indubitable proofs that water once covered all the exiſting continents, it follows that, when the ocean retired, or, which is the ſame in effect, when the dry land emerged from the ſea, vaſt inland ſeas or lakes would be left, at the bottom of which the SECONDARY STRATA were formed.

" As the ſea retired further, the higher grounds being left dry, theſe large inland ſeas or lakes would be contracted, and a number of ſmaller inſulated lakes would occupy the loweſt cavities and depreſſions; in each of which ſeparate depoſitions of ſtrata might take place. The lower ſtrata would therefore be the moſt widely ſpread, and the upper would conſtitute independent or *local* formations of greater or leſs extent, in which there might be great ſimilarity in ſome ſituations, and much diverſity in others. Now ſuch is found to be the fact. The above I conſider not as hypothetical aſſumptions, but as legitimate inferences from indiſputable facts, which will go far to explain the formation of the upper ſurface of the globe in a ſimple and intelligible manner, conſonant with its preſent phyſical ſtructure.

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* See Bakewell's introduction to Geology, pages 227, 228, 234—237, ſecond London edition. Not being an advocate for any geological theory, and wiſhing to preſent the leaſt exceptionable one to the reader, I have ſelected theſe remarks from Bakewell.

" On the continent of America, nature acts upon a magnificent ſcale. Were her operations attended to, they might illuſtrate many intereſting facts in geology. Since the banks of the cataract of Niagara were inhabited by Europeans, they have obſerved that it is progreſſively ſhortening the diſtance from Lake Erie to Lake Ontario. When it has worn down the intervening calcareous rocks and effected a junction, *the upper* lake will become dry land, and form an extenſive plain, ſurrounded by riſing ground, and watered by a river or ſmaller lake, which will occupy the loweſt part.

" In this plain future geologiſts may trace ſucceſſive layers of freſh-water formation, covering the ſubjacent limeſtone. The gradual depoſition of minute earthy particles, or the more rapid ſubſidence of mud from ſudden inundations, will form different diſtinct beds, in which will be found remains of freſh-water fiſh, of vegetables and of quadrupeds.*

" Large animals are frequently borne along by the rapidity of the current, and precipitated down the cataract. Their broken bones mixed with calcareous ſediment, may form calcareous rocks where the waters firſt ſubſide after their deſcent. Bones of quadrupeds are found thus intermixed in the calcareous rock at Gibraltar.

" Perhaps there was a period when the branches of Mount Atlas in Africa were united with the mountains of Spain, and the Mediterranean mixed its waters with the Atlantic through a narrow paſſage like that of Niagara. Theſe two ſeas would then have a different level, and a ſtupendous cataract might exiſt near the rocks of Calpe, and bury under its waves many of the animals that attempted to croſs the current.

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* Myron Holley, Eſq. after four years of attentive obſervation in the weſtern part of the ſtate of N. York, while Acting Canal Commiſſioner, is ſtrongly inclined to this theory of local formations.

"From the intermixture of theſe bones with calcareous ſediment, the preſent rocks with their oſſeous remains, may have originated. And theſe calcareous ſtrata may have been raiſed to their preſent elevation by a ſudden ſubterranean exploſion, which opened a paſſage for the waters of the Atlantic, and reduced both ſeas to their preſent level.

"I believe, that an enlarged view will be ſufficient to prove that all the ſtratified rocks above red ſandſtone, are local formations, which had their origin in detached hollows or ſeas of great extent, and are limited to certain portions of the globe."*

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* See Dr. Mitchill's remarks upon the ancient barriers in our diſtrict, in his appendix to Cuvier's Theory of the Earth.

STRATUM 11.

BRECCIA.

THIS ſtratum, like the red ſandſtone, ſeems not to be univerſal, in its proper geological place. But it is rarely wanting where the red ſandſtone is preſent. In our diſtrict it is chiefly confined to the Connecticut River range, and to the graywacke region in the ſtate of New-York. It is the only ſecondary ſtratum, which I have ſeen in place eaſt of the ſtate of New-York. I have lately been told however, by an intelligent young man, that not only graywacke, in which the grindſtone beds are found, but compact limeſtone and gypſum alſo, appear in the ſame order of ſucceſſion in Nova-Scotia, as in the ſtate of New-York. Mr. Hitchcock preſented to the Troy Lyceum a ſpecimen of bituminous ſhale with an impreſſion of a fiſh, which was taken from Connecticut river near Deerfield. Similar ſpecimens have been found at the Rhode-Iſland coal mines and at Middletown, Con. But I do not conſider this ſhale or coal as entitled to a place among regular ſtrata. *They* are unqueſtionably local formations; whether Bakewell's theory in relation to *all* ſecondary rocks be received or not.

It is a misfortune to this part of the ſcience of geology, that breccia is ſo often confounded with both red ſandſtone and puddingſtone by American geologiſts. Breccia in our diſtrict always reſts upon red ſandſtone and is generally reddiſh. Puddingſtone has no conformable poſition; and it conſiſts of mere maſſes of gravel cemented together, generally by carbonate of lime. Breccia, in the Connecticut river range and in the graywacke region in the ſtate of New-York, is made up of fragments of primitive rocks; moſtly of gneiſs rocks. Puddingſtone, wherever I have examined it, conſiſts of pebbles of graywacke, argillite, milky quartz, or of whatever conſtitutes the gravel of that immediate vicinity.

It is a remarkable fact, that, notwithſtanding the breccia of Catskill Mountains is ſeparated from the primitive rocks of Maſſachuſetts by twenty miles of argillite which contains immenſe quantities of milky quartz, it does not contain either argillite or milky quartz. I have examined the breccia on the higheſt part of Catskill Mountain, near the Delaware and Suſquehanna rivers, in Blenheim, and many other towns; and I find it contains a large proportion of that tranſlucent variety of quartz which forms a conſtituent of granite and gneiſs. The Connecticut river range differs only in containing more felſpar, and in being generally more friable.

I regret that I am not able to give a more diſtinctive characteriſtic for this ſtratum. For although I am never at a loſs in diſtinguiſhing it from the old red ſandſtone when I ſee it in place, I have not ſeen a ſatisfactory definition of it; neither am I able to ſupply one. It always contains rounded pebbles; or at leaſt rounded pebbles may be found within a few feet of any aſſumed point. It is ſaid that the old red ſandſtone ſometimes contains rounded pebbles alſo; if it does, ſuch pebbles are certainly not common. The breccia is always the uppermoſt rock; and, though frequently red and in ſome parts made up of fine grains ſo as to reſemble the red ſandſtone, if it is examined to the extent of a few yards, the evidences of its recent formation will become manifeſt. On Catskill Mountain, one mile ſouth of the upper lake, the breccia has crumbled off at its under ſide, ſo that a man may paſs between the breccia and red ſandſtone about twenty feet into the ledge. Similar appearances to a leſs extent are very common all the way to Suſquehanna river, wherever the breccia caps the high cliffs.

The bones of land animals and other relics found beneath what I denominate breccia, near Tappan,* demonſtrate this rock to be more recent than the old red ſandſtone of Catskill Mountains. But the beſt locality within my knowledge for elucidating this ſubject, is that which has attracted ſome notice at Ketch Mills ſix miles northeaſterly from Eaſt-Windſor church, Con. I had examined this range of red ſandſtone and breccia before the late diſcovery; but I have ſince taken means to have it re-examined with great care. Mr. Henry Newbury, a gentleman of reſpectable ſcientific acquirements, and the Rev. Sylveſter Eaton, made a perſonal examination of it on the 15th of the preſent month (April 1820) from whom I received the following account.

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* See Akerly's Geology of Hudſon's river.

The diſcovery of the remains of bones, ſuppoſed to have belonged to a land animal, was made by workmen while digging a well. They dug through five feet of alluvial earth, when they came to a reddiſh rock, into which they penetrated ſixteen feet. The rock is made up of ſeveral different layers, and the relics are found in the loweſt one. Some of the layers are as well characterized breccia, as any ſpecimens in the Lyceum. Others are finer grained, and appear like red ſandſtone. Some ſpecimens preſent the characteriſtics of breccia on one ſide and of red ſandſtone on the other. But rounded pebbles, often as large as a gooſe-egg, may be found more or leſs in all the layers. That in which the bones are embraced is pretty fine-grained generally; but rounded pebbles are found in all the fragments, now lying about the well, which contain bones. The workmen who dug the well, ſay that the rock was eaſily penetrated, excepting ſome of the layers which were made up of quartz pebbles.

From the above account it is evident, that a rock which is demonſtrated to be of recent formation by its encloſed relics, often preſents appearances nearly ſimilar to the old red ſandſtone. But that on a more extended view, the large rounded pebbles prove it to be breccia.

The proper breccia is interpoſed between the red ſandſtone and ſuperincumbent rocks at Northampton and Deerfield; and it would probably be found beneath every locality of theſe rocks if we could have acceſs to their baſes. Wherever the breccia repoſes on red ſandſtone in ſteep ledges, the diſtinction between the ſtrata is as ſtriking as between the former and baſalt.

Several aggregates are denominated breccia, which have no connexion with this ſtratum. Calcareous breccia, the *nagelfluh* of Werner, is connected with the compact limeſtone in our diſtrict. There is one locality two miles ſouth of the city of Hudſon adjoining the weſt ſide of South Bay road, and another two or three miles northweſt from a place in Chatham, Columbia county, called Federal Store. In Ulſter county the quartzoſe breccia is manufactured into millſtones. Mr. Olmſted, a ſtudent in Yale College, preſented to the Troy Lyceum a beautiful ſpecimen of agate breccia or ſilicious breccia, which he found two miles weſt of New-Haven. It conſiſts of ſemi-opal and chalcedony. The nagelfluh or calcareous breccia, which has been applied in building the Capitol of the United States, is well known. But all theſe ſhould rather be denominated breccioids than breccia; as they have no connexion with the ſtratum.

Miſſouri.* Dr. E. James found it reſting upon breccia near Ticonderoga. In the Heldeberg it invariably lies immediately upon ſandy graywacke; and there is no red ſandſtone nor breccia preſent.

The order of the formations is very well illuſtrated by the ſituation of this lime rock in the graywacke region, between Maſſachuſetts and Suſquehanna river. For though it is frequently found thouſands of feet lower than the tops of the mountains of graywacke, it is never under it. But it uniformly retains its ſuperior geological poſition, from the lofty cliffs to the loweſt valleys.

About two miles eaſt of Hudſon city is a field of compact limeſtone four or five miles in length and about a mile in breadth. It is completely inſulated, and reſts upon an inſulated hill of graywacke. For the graywacke is disjoined from the ſtratum to which it belongs, and lies upon argillite. Some part of this lime hill is ſufficiently compact for marble. Col. Darling of Hudſon has wrought ſome of it into moſt elegant chimney-pieces. The variegated hues, ariſing from the colouring matter of the various organized ſubſtances ſtill remaining, have a beautiful effect. The poliſh, given by the artiſt, tends to preſent the organic remains more clearly to view. I ſaw the moſt perfect forms of the *anthocephalite* (caryophillite) and *encrinite*, I had ever ſeen, in one of theſe poliſhed ſlabs.

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* See his view of Miſſouri mines, pages 199 and 228. The ſandſtone, not red, which he obſerved, is probably an upper layer of graywacke, or graywacke paſſing into ſandſtone, ſimilar to that in the Heldeberg, Catskill Mountains, &c.

Northweſt of Catskill village, along the Susquehanna turnpike, is another large field of ſhell limeſtone on graywacke ; and from two to three miles weſt of the village is another on the Little Delaware turnpike. Perhaps it would be more proper to ſay, that the range of compact limeſtone, which croſſes Glen's Falls in Saratoga county, continues down along the top of the graywacke ridge through the weſt part of Schenectady county, the Heldeberg, Renſſelaerville, Coeymans, Greenville, Hudſon, Catskill, Kingſton, Marlborough, &c. It is not a continuous ſtratum now however. It is rather a range of inſulated fields capping the hills of graywacke.

It is generally compoſed of a pretty looſe aggregate of bivalve ſhells; though in many places it is ſufficiently compact to be wrought as marble. At Coeymans it has been wrought as well as at Hudſon. A few miles below Albany a quarry has lately been opened, which promises much uſefulneſs.* In truth it may almoſt always be wrought at the depth of a few feet, where the ſhells have been pretty thoroughly diſintegrated.

Although this ſtratum is more continuous in the weſtern part of the ſtate of New-York and in all the weſtern ſtates than in the vicinity of Hudſon's river, it is often interrupted by creeks and valleys in thoſe regions. Wherever it is cut through, either the red ſandſtone, breccia, ſandy or brittle ſlaty graywacke, invariably appears.†

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* Dr. T. R. Beck.

† Extract from Mr. Henry R. Schoolcraft's communication, which was read before the Troy Lyceum.

"I conſider the preſent claſſification of ſecondary and alluvial formations as the moſt defective and unſettled part of geological ſcience; and confeſs myſelf unable to furniſh many facts on the ſubject.

The proper country for the ſtudy of this ſtratum is the graywacke region between the Hud-

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" Our theories ſhould be the reſult of obſervation, and facts ſhould never be diſtorted by theory. I have endeavored to adhere rigidly to this principle in all my reſearches. In my tour through the valley of the Miſſiſippi I collected ſome facts with a view to a geological map of that country; but I have ſaid little upon the ſubject, wiſhing for more time for obſervation and reflection.

" I ſaw no gypſum in Miſſouri or Arkanſaw in *ſitu*. The vaſt bodies of ſelenite, (cryſtallized gypſum) reported to exiſt near the Grand Saline, on the Arkanſaw, I mentioned on the authority of Mr. Sibley, of St. Louis. He made a perſonal examination, and brought away ſeveral beautiful ſpecimens. He gave no particulars reſpecting its geological ſituation, which are ſufficiently preciſe to be of any ſervice in a ſcientific point of view. In Illinois I ſaw ſmall quantities of cryſtallized gypſum, reſting in detached flakes upon ſecondary limeſtone, and alſo forming ſmall layers in it.

" A ſandſtone ſtratum is very extenſive in the valley of the Miſſiſippi. It is ſometimes mixed with calcareous particles ſufficient to exhibit a ſlight effervеſcence with muriatic acid. [See note to page 224] It is the baſis on which the ſecondary limeſtone of Ohio, Indiana, Illinois, Miſſouri, part of Kentucky, Tenneſſee, and Arkanſaw, reſts. It is the lower rock which is ſometimes ſeen a few feet above, and ſometimes a few feet below, the water on the banks of the Ohio, Miſſiſippi, Arkanſaw, White river, St. Francis, Black river, Gaſconade, Merrimack, and other ſtreams running into the Miſſouri—all of which I have particularly examined.

" Along the banks of the Ouachitta, in Arkanſaw territory, we find ſlate pervaded by large veins of common quartz rock. I ſon and the Suſquehanna. Here may be found hundreds of patches and fields of it; ſometimes

have not been far enough towards the territories of New-Mexico to ſpeak of the mineral phyſiognomy of that ſection of country. Neither have I travelled a ſufficient diſtance towards the Rocky Mountains to give an account of its geological character, nor how far its primitive ſpurs (if primitive) may reach towards the eaſt and north.

" The ſecondary limeſtone, which characterizes Weſtern America, is ſo vaſt, ſo illimitable, as to weary the patience, if it does not drain the pockets, of the travelling geologiſt. It extends far beyond the preſent ſettlements, into regions known only to hunters and ſavages.

" The inſulated ridge of granite, which I have noticed in Madiſon and Waſhington counties, Miſſouri, is an object of the higheſt intereſt. Surrounded by hundreds, and I might ſay by thouſands, of miles of ſecondary rocks, here repoſes one of the oldeſt of the primitive rocks—old red granite. The pinnacle of a primeval mountain, nearly ſubmerged by more recent depoſites, now hardened into rocks. Viewed in connexion with the ſurrounding country, it appears to me to preſent ſome unanſwerable arguments in ſupport of that theory which aſcribes the formation of the earth chiefly to the agency of water. If the Wernerians would frankly admit the partial agency of fire, no force of reaſoning appears capable of diſproving the doctrines they teach.

" From the north of this granitic tract extends a range of granular quartz, maintaining a paralleliſm with the Miſſiſippi for about 40 miles. This is occaſionally broken by rivulets, and terminates or diſappears near the banks of the river, between St. Genevieve and Herculaneum. A ſtratum of limeſtone, more extenſive than the granular quartz, *without organic remains*, extends *weſt of it ſo* far as to embrace the lead mines of Potoſi."

capping the higheſt mountains, ſometimes in a ſtate which clearly indicates its having ſlidden down from higher elevations, and ſometimes in boulders and blocks intermixed with alluvion. Its former existence is often teſtified by ſmall pebbles of it intermixed with pebbles of other ſecondary rocks; and by its ſerving as a cement in the formation of puddingſtone. A very perfect locality of this kind of puddingſtone is preſented in the bank of alluvion at the ſoutheaſt part of the city of Troy. It was a very important ſuggeſtion of Bakewell, that every ſtratum muſt have had its turn of being the uppermoſt of all ſtrata. When the compact limeſtone ſtratum was uppermoſt, there muſt have been much ſilicious matter in a ſtate of ſolution; for it is every where pervaded with the moſt perfect hornſtone. I have ſeen layers of it more than 20 feet in length and two inches thick near Bethlehem caverns, Albany county, ſome of which contain petrifactions. I found ſeveral ſpecimens at the ſame locality, which I depoſited in the Troy Lyceum, containing globular maſſes an inch in diameter of a lighter colour than the encaſing hornſtone. I conſider theſe as nodules of real flint.

That this ſtratum recently formed the bed of the ocean is manifeſt, from its being chiefly made up of oceanic relics. But whether the "mighty waters retired," two, three or four thouſand years ago, I preſume we ſhall never be able to aſcertain from any evidence preſented by theſe petrifactions. Dr. Mitchill obſerves, "On viewing theſe productions, the mind en-"deavors to fix that unaſcertained time, when "the oceanic waters of the primitive globe roll-"ed over this region."

This is the only cavernous ſtratum in North-America, and probably in the world. A few caverns have been found in other ſtrata; but they generally depend on accidental diſruptions or particular diſintegrations. This is the only ſtratum whoſe very ſtructure neceſſarily renders it cavernous. When the waters of the ocean retired, the calcareous cement, which now holds the ſhells together, was in the ſtate of a ſoft paſte. This may be proved by producing an artificial ſolution and proving by experiment, that it will not harden under water. After the waters retired, the parts expoſed to the ſun's rays began to harden, contract, and crack into blocks. In ſome parts of the Heldeberg theſe blocks are of great extent; but I have ſeen acres of it where the ſtratum is very thin, chequered up into blocks from two, to ten, feet ſquare. Where the ſtratum is very thick and the fiſſures very long, large caverns were frequently formed. For the upper ſurface of the ſtratum was ſoon dried and indurated; while the whole remained ſoft a long time a few feet below the ſurface. If a ſtream of water happened to flow in the vicinity of a fiſſure, it would probably make its way into it, and ſoon waſh away the looſe ſhells beneath the ſurface which were merely enveloped in ſoft calcareous paſte.

I have examined four of the largeſt caverns in the Heldeberg, and they all ſtill exhibit concluſive evidence of their having been once in the ſtate of mere fiſſures; and ſtreams of water ſtill traverſe them all. The largeſt of theſe caverns is the great cave at Bethlehem, twelve miles ſouthweſt from Albany. This is a few feet more than the fourth of a mile in length.* Throughout its whole extent we can trace the fiſſure overhead; though the edges of the rocks above have pitched in againſt each other ſo as to cloſe it.

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* It was accurately meaſured by my brother, Rev. Sylveſter Eaton.

The vaſt caverns of Kentucky containing nitrate of potaſh and nitrate of lime, deſcribed by Dr. Samuel Brown, of Alabama, and Mr. W. B. Stilſon, are in the ſame ſtratum. Alſo thoſe of Tenneſſee deſcribed by the Rev. E. Cornelius and by Mr. J. H. Kain. Mr. M'Conihe found many vaſt caverns and ſubterranean avenues in Indiana, all in the compact ſhell limeſtone. But there are no caverns in what is called the water-limeſtone, which on being made into a paſte hardens under water. This ſubſtance will be deſcribed under ſecondary ſandſtone.

Mr. M'Conihe diſcovered an extenſive layer of the true white lithographic ſtone in connexion with the compact limeſtone in Indiana. He has depoſited ſmall ſpecimens in the Troy Lyceum, preciſely reſembling that which Dr. Samuel Brown conſiders as the moſt perfect variety.*

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* Dr. Brown ſhowed me a ſpecimen of the ſtone, with ſpecimens of Mr. Otis' beautiful lithographic drawings. He would find abundant materials for this uſe in Indiana.

It has long been a ſubject of general remark, that no chalk is to be found in North America. But Mr. Schoolcraft found it in abundance along the banks of the Miſſiſippi, between the mouths of the Ohio and Miſſouri. It is in connexion with compact limeſtone, and contains flint nodules.*

The concentric globes of carbonate of lime, conſtituting a part of the rock of Gibraltar, are well known. Dr. Steel preſented to the Troy Lyceum hemiſpheres of ſimilar conformations, which he found near Saratoga Springs. They are three and four inches in diameter; but coarſe-grained, grey, and not variegated like thoſe from Gibraltar.†

Coal is found in connexion with compact ſhell limeſtone in the weſtern part of the ſtate of New-York. Mr. C. Atwater found it in the ſame connexion in the ſtate of Ohio. Mr. David Thomas obſerved it in many localities in the

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* See Schoolcraft's View of Miſſouri Mines, pages 180 and 227.

† Theſe maſſes or nodules ſeem to belong to Cleaveland's ſub-ſpecies, CONCRETED CARBONATE OF LIME.

Weſtern States—always in connexion with the ſhell limeſtone. The ſlate which he ſaw in connexion with it was unqueſtionably the bituminous ſhale, which generally overlays coal.

This ſtratum is not metalliferous. Mr. Schoolcraft found jaſper in it in Miſſouri, and nitrate of potaſh cryſtallized in crevices along extenſive rocks.* Very few imbedded or diſſeminated minerals, however, are found in it; excepting the various forms of calcareous cryſtals, and rarely a little ſulphate of lime.

Before I diſmiſs this ſtratum, I will extract, from the tranſactions of the Troy Lyceum, an article reſpecting the diſcovery of ſulphate of ſtrontian. "Mr. William A. Bird, the ſurveyor who accompanied Gen. P. B. Porter in running the boundary line between the United States and Canada, has returned with many intereſting facts and ſpecimens collected about the head of St. Lawrence and the Lakes Ontario and Erie. He diſcovered, in company with Capt. Douglas of Weſt-Point, a new locality of a mineral, which, by the experiments of Mr.

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* See pages 206 and 208, View of Miſſouri Mines.

Amos Eaton, performed before the Lyceum, proves to be cryſtallized ſulphate of ſtrontian.

" As ſeveral minerals have been taken for ſulphate of ſtrontian, which were afterwards found to be barytes; and as it is doubted whether there is any ſuch mineral in North America, it may be proper to give Mr. Eaton's teſts and experiments. He fuſed it and exhibited the purple flame before the blow-pipe. The melted globule gave a ſour taſte; though after four hours it fell to powder and gave the taſte of ſulphuretted hydrogen. He formed a muriate of it, which gave a blood-red flame, both in a dry powder and diſſolved in alcohol, when applied to a candle wick. Its ſpecific gravity appears to vary from 3.79 to 3.96, by repeated trials made by Drs. Wells and Hale; but moſt of the ſpecimens gave 3.85. It is the foliated variety, always tranſlucent and often tranſparent. Colour hyaline, often ſhaded with blue. Luſtre ſtrong and frequently irideſcent. The cryſtals are moſtly tabular with many oblique re-entering angles, preſenting a ſtriated appearance. Some cryſtals are rhomboidal priſms with two oppoſite truncated angles. This mineral is found in compact, and ſhell limeſtone, on Moſs Iſland, in Lake Erie, two miles weſt of Put-in-Bay."

Dr. John Torrey of New-York, has ſince analyzed this mineral and produced the ſame reſults, with ſeveral additional ones; demonſtrating it to be cryſtallized ſulphate of ſtrontian. This is the only locality of cryſtallized ſulphate of ſtrontian diſcovered in North America. It is doubtful whether any variety of this mineral has been diſcovered before in this country; though ſeveral localities have been publicly announced.

STRATUM 13.

GYPSUM.

IT is the opinion of many geologiſts, who have carefully ſtudied our weſtern rocks, that gypſum ought rather to be conſidered as forming beds in compact limeſtone, than as conſtituting a ſtratum. My knowledge on this ſubject is too limited to authorize an opinion. I ſhall therefore follow thoſe, who treat it as a ſtratum.*

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* Extract from a paper read before the Troy Lyceum by Iſaac M'Conihe, Eſq.

" My route was nearly through the centre of the population of Indiana, though far ſouth of the centre of the territory. It is the general underſtanding in the eaſtern ſtates, that all the weſtern part of the United States is of an even ſurface. Such at leaſt was my impreſſion, when I ſet out to journey to the weſt. Such is very generally the fact throughout much of the vaſt valley of

The gypſum of our diſtrict is remarkable for its dark brown and black cryſtals, or black ſe-

the Miſſiſippi. But the part of Indiana through which I travelled is as hilly as ſome parts of New-England, though the hills have moſtly rounded ſummits, and are denominated knobs by the inhabitants.

"This is evidently a ſecondary country; though tranſition rocks often appear. In fact, evidences occur at irregular intervals, ſufficient to lead the mind to the concluſion, that the whole country is underlaid at no great depth, with a continuation of the tranſition rocks which predominate in the vicinity of Hudſon's river in the ſtate of New-York. I found one locality of well characterized argillite at the bottom of a creek. This was among that range of hills, which commences at New-Albany, about six miles from the Ohio, and continues fifty or ſixty miles. Along the eaſtern edge of this range of hills, the red ſandſtone prevails, often of that hard ſlaty variety, common in Catskill Mountains. Detached maſſes of graywacke frequently occur here alſo. Whenever theſe tranſition rocks appear, the circumſtances attending them and their geological connexions clearly indicate that they are left in view, by the diſintegration of the ſecondary rocks, which had once overlayed them.

"Vaſt horizontal layers of ſecondary limeſtone are extended over moſt of this ſtate, which abound in organic relics. Theſe relics are moſt abundant, however, in ſome particular localities. In what is called the Barrens of Waſhington county, *Madreporites* of the horn-ſhaped variety appear in thouſands. *Pectinites*, *Anomites* and *Terebratulites* are found in every place, where there is compact limeſtone.

"About fifty miles from the Falls of the Ohio there is a locality of remarkably compact, fine-grained, variegated limeſtone, lenite. Carbonate of lime is frequently blended with it, even in its moſt extenſive localities; ſo that it often efferveſces with acids.

It is remarkable that, though the browniſh grey gypſum of Nova-Scotia gives a white ſtreak, the ſame coloured gypſum of the ſtate of New-York gives a grey ſtreak. This fact was firſt noticed by plaſter grinders. They obſerved that the ſame coloured gypſum, which, if

Alternating with its layers I found large quantities of the true white lithographic ſtone; now becoming a very important mineral, ſince Dr. Samuel Brown, of Alabama, introduced the lithographic art into this country. I have depoſited ſmall ſpecimens of it in the Troy Lyceum.

"Near this place workmen were engaged in digging a well. I took ſpecimens from the fragments of two rocks, which ſeemed to be in place about thirty and thirty-five feet below the ſurface, and merely noted down their relative poſitions and locality. On examining them ſince, I find the lower rock to be *gypſum*, overlaid with ſecondary calcareous ſandſtone.

"The lime rocks of this ſtate are remarkably cavernous. There are ſeveral pretty large ſtreams of water, which diſappear for miles through the vaſt fiſſures and cavities in theſe rocks. There is one, whoſe return to open day has not yet been diſcovered.

"In the alluvion I found well characterized fragments of agate. Alſo chalcedony, semi-opal and fine ſinople jaſper."

from Nova-Scotia gave a white flour, would give aſhes-coloured flour if it was obtained from the weſt.

Gypſum is very abundant in the counties of Madiſon and Onondaga, New-York; particularly in the towns of Sullivan, Manlius and Camillus. Mr. D. H. Chapman preſented fibrous gypſum of the moſt beautiful kind, which he obtained at Manlius. The fibres are four inches in length, a little curved, of a pearly white colour, and of much firmer texture than the ſpecimens from Nova-Scotia.

I have not been informed of the diſcovery of any organized remains in the gypsum of the weſt; though it is overlayed with, and is repoſed upon, ſtrata which abound in them.

Sulphate of lime is frequently found attached to other rocks in ſmall ſpecimens. Theſe ought to be called ſulphate of lime merely, not gypſum; becauſe the latter name is calculated to excite falſe expectations. Wherever the ſoft granular variety of iron pyrites is diſſeminated in carbonate of lime, the pyrites becomes decompoſed on expoſure and ſulphate of iron is produced. Whenever the latter ſubſtance is waſhed down on the ſurface or in the fiſſures of carbonate of lime, the carbonate is decompoſed and the ſulphate is produced. Dr. Mitchill obſerved this proceſs going on at Niagara Falls. I found a graywacke ledge faced with this formation of ſulphate of lime in Blenheim on the weſt bank of the Schoharie.

I have never been informed of any anhydrous gypſum in our diſtrict. Neither have I ſeen any ſufficiently white and compact to form alabaſter.

It appears from the obſervations of M'Clure, Mitchill, Mr. Caleb Atwater and others, that rock-ſalt accompanies the gypſum along the great range which extends from Onondaga lake to the ſtate of Tenneſſee. M'Clure obſerved the ſame connexion in Poland, Europe.

Since I wrote the above, I received a letter from Auſtin Abbott, Eſq. the Correſponding Secretary of the Hudſon Scientific Aſſociation, aſſuring me, on the authority of Walter Patterſon, Eſq. that patches of gypſum are ſometimes found on the compact limeſtone ridges near Ancram furnace, in Columbia county.

STRATUM 14.

SECONDARY SANDSTONE.

I REGRET that it is not in my power to preſent the reader with many facts, relating to this ſtratum, which have fallen under my *own* obſervation. I have received no evidence of its exiſtence eaſt of the river Hudſon; though it appears to be of great extent to the weſt.

This ſtratum had never been deſcribed to me, neither had I ſeen a ſpecimen in any cabinet, when I viſited a locality of it on the Helderberg, in company with the Preſident of the Troy Lyceum and Dr. T. R. Beck. We were perfectly at a loſs in labelling our ſpecimens taken from this rock; neither did we then ſettle its geological poſition. After two more viſits in company with ſeveral members of the

Lyceum, and after attentively reading Bakewell's deſcription of ſeveral varieties of ſecondary ſandſtone, as well as thoſe of other European geologiſts, we ventured to denominate it Secondary Sandſtone.

It is chiefly ſilicious and very fine grained; rarely containing carbonate of lime ſufficient to efferveſce with acids. It is grey, yellowiſh or browniſh. The beſt locality in the Heldeberg is a little eaſt of Pucker-Street; where the rock is divided by open fiſſures or ſeams into pretty regular blocks. Theſe fiſſures appear like artificial cuts; and the blocks preſent faces almoſt as ſmooth as if wrought by the chiſſel. This rock abounds in organic remains, apparently of more recent formation than thoſe in compact limeſtone. Culmiferous petrifactions frequently occur, and the animal remains are often eaſily ſeparated from the rock in a very perfect ſtate.

It reſts upon compact limeſtone generally. I found one locality however, where the limeſtone was wanting for ſeveral feet; and here it lay immediately on the ſandy graywacke, which underlays the limeſtone. The floor of a cavern two miles north of Pucker-Street is graywacke, the walls are compact limeſtone, and the covering is ſecondary ſandſtone abounding in *favoſites* and *encrinites.*

From the obſervations of geologiſts, who have travelled in the weſtern country, I am inclined to conſider the ſecondary ſandſtone of the Heldeberg as the loweſt layer of this ſtratum, which may have been once covered with ſeveral others. And I am inclined to believe, that future obſervations will demand a ſubdiviſion of this ſtratum into three or four. It is probable that at leaſt one of theſe ſubdiviſions ought not to be called ſandſtone. But I prefer treating them as ſubordinates or varieties, to running the risk of creating untenable ſubdiviſions.

I am indebted to my friend and claſs-mate, Myron Holley, Eſq. Canal Commiſſioner, for the moſt important facts reſpecting this ſtratum. In conſequence of the enquiry, which the Heldeberg locality and ſome ſpecimens brought to Albany by Mr. Holley in the winter of 1819, had excited, he ſtudied this ſtratum attentively, while engaged in his official duties along the great Weſtern Canal. He obſerved it all the way from near the eaſt bounds of Madiſon county to the weſt bounds of Niagara, a diſtance of almoſt two hundred miles. It generally reſts upon ſhell limeſtone, where its ſupporting ſtratum is in view. Wherever the gypſum occurs, it invariably lies beneath this ſtratum. He refers more particularly to the gypſum beds in the towns of Sullivan and Manlius. He preſented ſpecimens to the Troy Lyceum, which are ſimilar to thoſe which Mr. M'Conihe found overlaying gypſum in a well in Indiana.

Wherever Mr. Holley obſerved the order of the layers conſtituting this ſtratum, particularly where the works on the Canal required that they ſhould be cut through, they were found as follows. The uppermoſt layer is very coarſe ſandſtone or gritſtone, moſtly ſilicious and abounding in organic relics. The next layer below it is light grey, and contains conſiderable carbonate of lime. The next is bluiſh and blue, and is chiefly carbonate of lime with ſome alumine and a little ſilex. The loweſt layer is the *water limeſtone.* This laſt is the ſtone which hardens under water, after being burned, pulverized and made into a paſte.* It conſiſts of carbonate of lime, alumine and ſilex, with a little oxyd of iron. In the ſpecimens which Mr. H. preſented to the Troy Lyceum, grains of gypſum are diſſeminated.

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* This remarkable property, hardening under water, was diſ*covered by* Canvaſs White, Eſq. one of the Canal Engineers. He

Mr. M'Conihe examined a well twenty-five feet deep in this ſtratum, ſeventy miles weſt of Vincennes in Illinois, on a riſing ground, which preſented the following layers. The uppermoſt was rather coarſe calcareous ſandſtone. The next ſeemed to be a talcoſe ſandſtone, of a ſlaty ſtructure. The next calcareous ſand, in a looſe ſtate. The loweſt was almoſt wholly ſilicious ſandſtone.

From a compariſon of ſpecimens from the two localities, obſerved by Mr. Holley and Mr.

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went to England to examine the canals of that country; and particularly to acquaint himſelf with the Engliſh method of conſtructing locks. On his return he brought home ſpecimens of the rock, called *ſeptarium*, which is uſed for locks on account of its hardening under water. He thought it reſembled this variety of ſecondary ſandſtone; and on making trial, he found it to be equally well adapted to this uſe. The benefits reſulting from this diſcovery in conſtructing locks and ciſterns, is incalculable.

Mr. Hadley, Profeſſor of Chemiſtry in the Fairfield Medical Academy, carefully analyzed it, and gave the proportions of all the conſtituents.

M'Conihe, it appears that the layers are in ſome meaſure analogous, but not ſimilar. Is not this good evidence in proof of Bakewell's theory of local formations? It certainly accords with his inference, that "there might be great ſimilarity in ſome ſituations, and much diverſity in others."

IV. SUPERINCUMBENT CLASS.

STRATUM 15.

BASALT.

WHEREVER I have had acceſs to the baſis of a greenſtone trap rock in place, I found it reſted on a fine-grained variety, quite as fine as any ſpecimens of European baſalt. It is generally porous; being of that variety called amygdaloid, or toadſtone. But ſpecimens may be obtained ſeveral feet in extent, perfectly compact, without a pore.

This ſtratum is not only very different from the common greenſtone trap in its texture; but its meeting with the greenſtone is always conſpicuous. The two ſtrata do not paſs into each other by imperceptible gradations, nor alternate like ſome other ſtrata. The weſt ſide of Mount Holyoke on Connecticut river, and the weſt ſide of Deerfield hill eaſt of the academy, are good localities. Alſo moſt of the ridge of rocks which extends along the northweſt ſide of Salſtonſtall's pond in Eaſt-Haven, four or five miles eaſt from New-Haven.

In Deerfield there are baſaltic columns of a polyhedral form; in all reſpects reſembling the joint of a baſaltic column in Gibbs' cabinet from Giant's cauſeway, and of quite as compact a texture. Theſe columns were firſt obſerved by Mr. Hitchcock. But were I to diſpoſe of theſe rocks according to my own views of this ſubject, I would place theſe columns as well as thoſe of Giant's cauſeway with the greenſtone trap; and make a diſtinct ſtratum conſiſting of the fine grained baſalt, including the amygdaloid. For theſe two varieties often compoſe the ſame individual rock, and are much finer grained than the columns from Ireland. I have a ſpecimen of baſalt from Scotland, preciſely reſembling the fine baſalt of Mount Holyoke, which underlays the greenſtone columns.

The baſalt of our diſtrict is remarkable for the numerous ſmall minerals embraced in it. In Deerfield Mr. Hitchcock conducted me to a locality of this rock which contains prehnite, zeolite, chalcedony, agate, ſardonyx, analcime, chabaſie, ſtilbite, amathyſtine and lamellar quartz, and calcareous ſpar.. Many of theſe minerals have been found at Mount Holyoke and Salſtonſtall's pond. Mr. Pierce found prehnite, zeolite and ſtilbite in this rock in New-Jerſey.

I found ſpecimens of this rock a little north of the greenſtone columns in Mt. Holyoke, which reſemble blackſmiths' cinders. The variety called amygdaloid is remarkably cellular; and the cells appear like thoſe in light bakers' dough. Bakewell conſiders this peculiar ſtructure as evidence of its having been fuſed and cooled under water, probably under the ſea. "Theſe beds of baſalt," he ſays, "were formed under the ſea by the ejection of lava, which flowing over the moiſt ſubmarine ground, would confine a portion of water beneath the melted maſs.

This water would be converted into elaſtic vapor, or ſteam, which would endeavor to expand. But where the ſuperincumbent preſſure prevented its eſcape, it would form cavities." He ſuppoſes the ſame eruption might form the cellular amygdaloid and compact baſalt; as it would naturally be cellular below and compact above.*

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* See Bakewell's Introduction to Geology, pages 141 and 142.

STRATUM 16.

GREENSTONE TRAP.

IN our diſtrict this rock appears as if piled upon other ſtrata artificially. And Dr. J. W. Webſter repreſents the greenſtone about Edinburgh as preſenting a ſimilar appearance.* Travellers frequently compare them to the ruins of ancient caſtles.

There is a range of greenſtone hills extending from New-Haven, Con. through the weſt pariſh of Hartford, through Northampton and Deerfield, to Greenfield; a diſtance of about one hundred miles. The three eminences arranged about New-Haven, denominated Eaſt Rock, Pine Rock and Weſt Rock, belong to this range. The monument, or obſervatory, weſt of Hartford is built upon a greenſtone hill belonging to this range. Mount Holyoke and Mount Tom, near Northampton, are inſulated fields of the ſame broken chain.

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* See his sketch in the Am. Jour. of Sci. p. 231.

The range of this rock, which has excited the moſt attention, is that called the Paliſadoes. It commences below the Highlands on the weſt ſhore of the river Hudſon, and extends along, forming its weſtern bank, with but one interruption, for thirty-eight miles. Oppoſite to the city of New-York it winds away weſterly, acroſs the ſtate of New-Jerſey to the diſtance of eighty miles.* The ſublime emotions excited by the grandeur of theſe ſtupendous columns are familiar to the many thouſands who have ſailed up the Hudſon.

In various parts of the greenſtone trap of our diſtrict, we find very perfect polyhedral columns; and almoſt every where a polyhedral or rhomboidal tendency. The ſouthweſt ſide of Mount Holyoke preſents a colonnade of the moſt perfect polyhedral pillars; imitating the niceſt works of art. Joints of the columns are broken out in ſome places, ſo that the upper ones preſent their convex baſes, reſembling the bottoms of large potaſh kettles; while the concave joints below will contain ſeveral gallons of water. The rock is remarkably fiſſile in every part of this mountain. When a joint of theſe columns falls, it is ſhivered into a thouſand pieces.

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* See Dr. Akerly's Geology of Hudſon river, pages 27—32.

The columns of Weſt Rock, New-Haven, are not ſo regular in form; but they are not ſo fiſſile. Beſides, they break more readily into blocks ſuited for building-ſtone. Moſt of the walls in New-Haven are built of this rock.

The greenſtone trap of our diſtrict generally reſts upon red ſandſtone or red breccia. But there is a place at the ſouthweſt end of Mount Holyoke, where it ſeems to ſink down into a rent or fiſſure in the red ſandſtone, paſſing under Connecticut river. There is a ſimilar appearance at Deerfield river, juſt above its mouth, where it empties into the Connecticut.

A Scotch gentleman,* who has attended Jameſon's lectures in Edinburgh, on examining my ſpecimens from Mount Holyoke, pronounces them the true *whinſtone* of Scotland. This rock affords but few diſſeminated minerals. The fiſſures are ſometimes faced with carbonate of lime, and rarely with zeolite. Mr. Silliman found conſiderable of the latter mineral in horizontal veins in Pine Rock. And I found conſiderable dark brown augite in the ſame locality. Mr. Silliman ſays, that moſt greenſtone, if heated and pulverized, will form a water-proof mortar.*

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* Dr. M'Naughton of Albany.

Are baſalt and greenſtone trap of volcanic origin? This ſeems to be a ſubject of very general diſcuſſion among modern geologiſts. Bakewell ſays, "I am inclined to think that "the part of Dr. Hutton's theory, which re- "lates to the igneous origin of baſaltic rocks, "is as well eſtabliſhed as the nature of the ſub- "ject will admit of; other parts of the ſyſtem "are much leſs ſatisfactory.†

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* See his note to the 142d page of Bruce's Journal.

† Page 135.

V. ALLUVIAL CLASS.

STRATUM 17.

GEEST.

THIS is the moſt univerſal of all ſtrata. Every inch of dry land, which is neither naked rock nor covered with alluvion, is ſtrewed over with geeſt. Its character is generally indicated by the rock upon which it lies, and by thoſe which have recently diſappeared.*

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* Extract from an eſſay which I wrote for the Journal of the Board of Agriculture, publiſhed at Albany, page 58.

"The principal diſintegrating agents are water and change of temperature. In all rocks we find natural cleavages. Rains and melting ſnows fill theſe cleavages with water; which, on freezing, extends its volume, and thereby ſubdivides the maſs of rock into ſmall portions. More ſurface being thereafter preſented to the through Pittsfield and Dalton, there is conſiderable calcareous and ſilicious geeſt and ſome alluvion.

Between the weſt bounds of Maſſachuſetts and the river Hudſon, the ſoil is chiefly argillaceous and ſilicious geeſt, compoſed of argillite and graywacke. Between the Hudſon and Suſquehanna rivers, along our ſection, it is more ſilicious, though a parallel ſection might be drawn about fifty miles north, which would paſs through a country of alluvion alternating with calcareous and argillaceous geeſt. In our ſection, however, there are many patches of argillaceous geeſt, formed of the argillaceous layers of graywacke. There are alſo many patches of deep alluvion.

"In the eaſtern parts of Columbia county the ſlate rock has paſſed away and left the granular limeſtone, which is the next ſtratum beneath it, bare. Near what is called Canaan Corner, is a manifeſt locality. Conſequently, the diſintegrating agents have commenced their attack upon it, and will greatly improve the neighbouring ſoil by the addition of carbonate of lime. In the weſtern part of the ſame county, the upper, or ſecondary, ſtratum of limeſtone ſtill remains above the graywacke. Conſequently the ſoil is daily improved in that diſtrict by the mouldering down of that rock."

On a general view of our diſtrict, we may conſider the New-England ſtates and the north, eaſt, and ſoutheaſt, part of the ſtate of New-York, as the proper territory of geeſt. This portion of our diſtrict, however, embraces ſeveral hundred ſquare miles of alluvion. Particularly along the banks of the great rivers, near the ſhores of the ſea and on the iſlands.

Though this ſtratum is generally made up of the diſintegrated fragments of the neareſt rocks, ſome of its conſtituents appear, in many localities, to have been tranſported from a conſiderable diſtance. More eſpecially where it is ſituated near the baſe of a high mountain. There may alſo have been conſiderable commixture between the geeſt of different parts of level tracts, before the ſubſidence of the oceanic waters left it bare. But it generally appears to be very nearly related to the exiſting baſis rock.

STRATUM 18.

ALLUVION.

HITHERTO there has been no ſubdiviſion of this ſtratum, founded upon the relative ages of different layers. Gravel, ſand, clay and loam are ſaid to compoſe this ſtratum; either, or all, of which may be in any place or of any age. After I had collected my materials for this ſtratum and arranged them in the uſual way, I received a letter from Mr. Henry R. Schoolcraft which ſet me upon a new courſe of enquiry. He propoſes to ſubdivide this ſtratum according to the relative ages of the different kinds, and aſſigns diſtinctive characteriſtics for each kind. It would be very gratifying to me to publiſh his letter; but it was written in haſte at the laſt moment of his departure on the Northweſtern expedition with Gov. Caſs, and in a familiar ſtyle which evinces that he did not expect me to take that liberty.

After applying his ſuggeſtions to all the facts within my knowledge, I am inclined to conſider the three-fold diviſion, which he propoſes as hardly tenable. I ſhall attempt a two-fold diviſion, upon this plan, leaving all further improvement to be made by Mr. S. after his return, when his ſtock of materials will be fully adequate to the object.

Primary Alluvion.

This is that kind of alluvion, which appears to have been formed when the earth, or at leaſt that portion of it in the vicinity of ſuch alluvion, was deſtitute of vegetables. Conſequently there are no trunks of trees, nor other vegetable remains, embraced in it nor under it. The alluvion embracing the iron ore beds of Saliſbury, Con.* is a very perfect example. The banks of alluvion along the eaſt ſide of this city (Troy) are alſo primary. Mr. Schoolcraft conſiders the alluvion embracing the lead ore of Miſſouri as truly primitive. I have ſeen ochre in Williamſtown, Maſs. and in Blenheim, N. Y. in this kind of alluvion; alſo bog ore in the latter place, and in the Highlands.

Having examined but few localities ſince this very intereſting ſuggeſtion reached me, I dare not venture to name even thoſe localities, with which I am very familiar. Theſe remarks will be ſufficient to induce the reader to make thoſe enquiries, which will materially aid this department of the ſcience.

Secondary Alluvion.

This kind always embraces or covers trunks of trees, vegetable mould, or ſome other remains, which proves its formation to have taken place ſince the earth's ſurface has been adorned with "an abundant vegetation." Such is the bed of alluvion on which this city, (Troy) is built. It appears by digging the wells in this city, that after deſcending from fifteen to twenty feet through the coarſe gravel, there are two or three layers of tough clay. Among this clay are found great quantities of leaves, trunks and limbs of trees, &c. There is now in the

Troy Lyceum a fragment of the *pinus canadenſis* (hemlock tree) which was interpoſed between two layers of this clay twenty-five feet below the ſurface.

Moſt of Long-Iſland and other alluvial localities in the vicinity of New-York are ſecondary alluvion. It appears alſo, that the alluvion forming all the eaſtern portion of the Southern ſtates, is of this kind.

A few miles ſouth of Lake Ontario there is a large tract of ſecondary alluvion, containing argillaceous oxyd of iron of the lenticular variety. The alluvion is reddiſh and ſeems to be underlaid with red ſandſtone. The ore frequently contains very perfect, though extremely minute, *volutites*. They are perfect petrifactions, being wholly compoſed of the argillaceous oxyd of iron, though they are of the ſame ſpecies as thoſe minute *voluta* now common in the living ſtate. Excellent iron is manufactured from this ore; and the Legiſlature of this ſtate have granted a loan to Gen. M'Clure and A. Cole, Eſq. to enable them to carry on the manufacture of it to advantage. Theſe gentlemen, from whom I received this deſcription of the alluvion, preſented to the Troy Lyceum ſpecimens of the ore with a bar of the wrought iron. On an analyſis we find that it yields a little over thirty per cent of pure iron. The Rev. R. Searle found a ſimilar locality of ſmall extent twenty-five miles ſouth of lake Erie.*

The bones of large animals are frequently found in the ſecondary alluvion; alſo vaſt quantities of ſhells in a perfect ſtate of preſervation. Though large bones have been found near Newburg on Hudſon river, &c. yet they are more frequent in the alluvion of the Weſtern ſtates.

It is worthy of notice, that trunks of trees, which have lain for centuries in deep alluvion in a ſound ſtate, will decay in a very few months when dug up and expoſed. I have ſeen a ſound log, one foot in diameter, totally rotted into a powder in one year, which had been thrown up from a conſiderable depth by the roots of a falling buttonwood (platanus occidentalis) of an enormous ſize, probably one hundred years old. Similar obſervations are frequently made by well-diggers in alluvial diſtricts.

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* See American Jour. Science, page 239.

The peat beds of New-Haven, of Dutcheſs county,* &c. belong to this kind of alluvion; alſo many anomalous rocks of recent local formation. Thoſe petrifactions which are formed of calcareous tufa, as the enormous lignite discovered by Mr. J. C. Heartt in Madiſon county, are proper ſubjects of this formation. There is in the Troy Lyceum a very extraordinary ſpecimen of *holzſtein* (ſemi-agatized wood) which was taken from ſecondary alluvion near Mobile. It is the trunk of a tree fifteen inches long and ſix inches in diameter. Forms of knots upon it are very perfect, and the grains of the wood diſtinctly imitated. Its moſt remarkable peculiarity is, that ſeveral petrified ſpecimens of *Xyloſtroma gigantea* are contained in cleavages of it, which ſtill retain the natural colour of that fungus.

To enumerate the many ſubſtances contained in ſecondary alluvion would exceed the plan of this Index. Indurated marl is found in it near Albany, Troy, Catskill, and in numerous other localities in the ſtate of New-York. In New-England marl is extremely rare. Dr. Wm.

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* Rev. F. C. Schaeffer.

Bridgman found it however, in Wilbraham, Maſs. of a reddiſh hue, and I found a grey variety at Northampton in ſmall quantities. Petroleum (liquid bitumen) often iſſues from this kind of alluvion and forms an irideſcent pellicle upon ſtanding waters. Vaſt quantities of it are found at Seneca Lake, where it is called mineral oil. Dr. Mitchill found native ſulphur in it at Clifton Springs near Geneva. Mr. C. I. Wiſtar found amber in it with coal near Trenton, N. J. and Mr. Godon found at Allenstown an excellent pigment of blue earth containing phoſphate of iron.*

Moſt waters, which paſs through clay alluvion, contain muriatic acid, (ſpirit of ſalt) generally combined with lime. A ſolution of muriate of ſoda is often found in other varieties of alluvion; but it ſeems to paſs through them with rapidity, and on its paſſage to be decompoſed by carbonate of lime and to be detained only in the adheſive and compact layers of clay. I cannot give my views of this ſubject better, than to tranſcribe a ſhort paper which I read before the Troy Lyceum.

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* Mr. Schoolcraft obſerved pebbles of granite, gneiſs and hornblende rock, intermixed with the ſandy and calcareous alluvion, in the vicinity of the Vienna gypſum, Ontario county: which is very far from any locality of theſe rocks, being in the midſt of a ſecondary country.

" From the experiments and obſervations of Dr. J. B. Beck,* Dr. John Torrey,† Dr. S. Akerly and others, it appears that ſome ſtorms bring with them large quantities of muriate of ſoda (common ſalt) to a little diſtance from the ſea. Are there not ſufficient reaſons for believing that many ſtorms bring with them muriate of ſoda far into the interior, or even acroſs the continent? I do not intend to detain the members of the Lyceum with a long diſſertation upon this queſtion. But I will relate a few facts which have come to my knowledge, with a view to induce further enquiry.

" I have analyzed what is called the hard water of wells in Waterford, Lanſingburgh, Troy, Albany, Hudſon, Athens, Catskill, Cairo, Durham and Blenheim, in the ſtate of N. York, and I find, they all contain muriate of lime. There is no difficulty in accounting for the preſence of the lime; but whence comes ſuch an immenſe and continued ſupply of muriatic acid? For there is no evidence of the exiſtence of any ſalt mines in or near theſe localities. But ſince they are all embraced in a tranſition country, we are authoriſed to preſume there are none.

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* Am. Jour. Science, p. 388.

† Note to page 390.

“ May it not be ſupplied by ſtorms, bringing with them muriate of ſoda into the *interior* of our continent, as well as near the ſea-board, differing only in quantity? Troy is about one hundred miles from New-Haven, which is the ſhorteſt diſtance to the ſea, and Albany is but ſix miles from Troy. Now I have teſted water, falling in ſudden ſhowers and long rain-ſtorms, repeatedly, at both theſe cities with the beſt prepared nitrate of ſilver, and generally found that it contained muriatic acid. I have not always found it in ſnow water, but I did at one fair trial in Albany.

“ To avoid the poſſibility of error, I always collected it in a glaſs veſſel placed in an open yard at a diſtance from any building or tree. And in order to be ſure that no muriatic acid could by any poſſible means adhere to the veſſel, I always filled it with pure water, teſted by nitrate of ſilver, the laſt moment before I began to collect the water.

“ Is not one of the proviſions of nature for fertilizing ſoils and correcting impurities, that of tranſporting ſea-ſalt to every part of all iſlands and continents, in combination with aqueous vapor? Are not all other methods of accounting for the almoſt univerſal preſence of muriatic acid in ſoils at variance with known phenomena?”

The rapidity with which alluvion is formed is incalculable. The following obſervations upon the quantity which paſſed by Albany, during three days of the freſhet of April 1819, may be ſomewhat intereſting. That part of the river, which included the ſtrength of the current during the freſhet, was 1320 feet wide and fifteen feet deep on an average; giving the area of a tranſverſe ſheet of 9800 ſquare feet, oppoſite to the Steam-boat dock. By meaſuring the diſtance from this dock to the ferry ſtairs, and repeatedly marking the time required for logs, bruſh, roots, &c. to paſs this diſtance, I aſcertained that the average velocity of the waed. In accordance with this fact, we now perceive that there are no petrifactions, or organized remains of animals or vegetables in the earth, excepting thoſe which are intermixed with the outer and more recent ſtrata, evidently derived from the earth's ſurface.

2. Aquatic animals were formed firſt according to Moſes. This is confirmed by the eſtabliſhed fact, that no other relics, but thoſe of the aquatic kind, are contained in tranſition rocks, which are the oldeſt containing any relics.

3. Dry land animals and plants were formed ſubſequent to the creation of aquatics according to Moſes, and before the creation of man. Now we find the remains of dry land animals and plants in the newer, or ſecondary, rocks; but not the fragment of a bone or any other part of man has ever been found in either tranſition or ſecondary rocks.

4. Man was created laſt, after the earth was completed and parts of it covered with herbage; of courſe after the proceſs of diſintegration had commenced and ſoils were formed. In con-

firmation of this fact, we find the remains of man no where but in the alluvion, out of which he was formed. A ſpecimen has been found in Guadaloupe conſiſting of part of a human skeleton, embraced in an aggregate of calcareous ſand, conſiderably indurated; but not in a ſecondary rock ſtratum.

5. Moſes ſays, the Lord made "every herb of the field before it grew"—"whoſe ſeed is in itſelf," &c. This accords with the well known fact, that new plants are ſtill ſpringing up from ſeeds, probably planted at the creation, wherever foreſts are cut away and other ſteps taken to prepare particular patches of earth for giving growth to ſuch particular plants. It is even ſaid, that pulverized rocks have been known to afford ſeeds and to give growth to new plants. Perhaps this latter fact is not well authenticated.

It is true that ſix days is but a ſhort ſpace of time for the depoſition of ſtrata and for thoſe other events to have tranſpired in ſucceſſion. But we know that all operations were haſtened in effecting ſo much in ſo ſhort a time; and we are only to believe, what is certainly moſt rational, that though theſe operations were haſtened, the Almighty eſtabliſhed laws for governing his works at the very firſt, and endowed the firſt created atom with its preſent properties.*

I do not pretend that this coincidence of ſcripture hiſtory and geological diſcoveries is alone ſufficient, or at all neceſſary, to ſupport the authenticity of Divine Revelation. But it is not unworthy the attention of the geologiſt. Suppoſe this order of things were reverſed. Suppoſe the remains of man alone were found in primitive rocks, dry land animals and plants alone in tranſition, and aquatics alone in the moſt recent ſecondary rocks, would not every Deiſt declare this to be concluſive proof, that ſcripture hiſtory could not have been given by inſpiration?

From theſe few remarks it appears that, by attentively ſtudying the preſent ſtructure of the earth, and by duly conſidering the millions of organized beings whoſe remains are almoſt every where in the more recent ſtrata, we may arrive at ſome correct views of the hiſtory of our planet. Cuvier ſays, "would it not be glori-"ous for man to burſt the limits of time, and, "by a few obſervations, to aſcertain the hiſto-"ry of this world, and the ſeries of events "which preceded the birth of the human "race?"

---

* Some learned Divines ſuppoſe each day to have been a thouſand years, ſince with the Almighty "a thouſand years are as *one day*, and one day as a thouſand years."

Many of the great revolutions which our earth has undergone can be traced by exiſting monuments within our reach. "When the "traveller," ſays the illuſtrious Cuvier,"* "paſſes through thoſe fertile plains where gen-"tly-flowing ſtreams nouriſh an abundant ve-"getation, and where the ſoil, inhabited by a "numerous population, adorned with flouriſh-"ing villages, opulent cities and ſuperb monu-"ments, is never diſturbed except by the rava-"ges of war and the oppreſſion of tyrants, he "is not led to ſuſpect that *Nature* alſo has her "inteſtine wars, and that the ſurface of the "globe has been much convulſed by ſucceſſive "revolutions and various cataſtrophes. But "his ideas change as ſoon as he digs into that "ſoil which preſented ſuch a peaceful aſpect, "or aſcends the hills which border the plain."

---

* See Cuvier's Theory of the Earth, New-York Ed. p. 29.

Shells and other marine productions "are "found in elevations far above the level of every part of the ocean, and in places to which "the ſea could not be conveyed by any exiſting "cauſe. Still we are forcibly led to believe, "not only that the ſea has at one period or "another covered all our plains, but that it "muſt have" overtopped the hills and "remained there for a long time in a ſtate of "tranquillity."——"The breaking to pieces "and overturnings of ſtrata ſhow plainly that "thoſe cataſtrophes were ſudden and violent. "Life, therefore, has been often diſturbed on "this earth by terrible events."

I will not detain the reader with any further *general* reflections upon the hiſtory or preſent ſtructure of the earth. The works of Cuvier, Bakewell and De Luc contain every thing to gratify the moſt brilliant fancy, or the moſt rational curioſity. But with reſpect to our own country I will ſuggeſt, that if we ſuppoſe moſt of the primitive rocks to extend throughout North-America, ſometimes ſupporting other ſtrata and ſometimes expoſed to our view from the diſruption or diſintegration of the higher ſtrata, almoſt every geological phenomenon may be explained. We ſhould then ſay, that in New-England the granite does not lie very low any where; and that in certain places it is laid bare. That in the weſtern ſtates it generally lies very low, and is entirely concealed by tranſition and ſecondary rocks. And that beyond the Miſſiſippi it is conſiderably elevated, ſo that it becomes viſible in Arkanſaw. Alſo that it comes ſo near the ſurface for ſeven hundred miles along the weſt ſide of the Miſſiſippi, as to raiſe up its aſſociates, granular quartz and primitive limeſtone, to view.*

---

* See Schoolcraft's obſervations in a note to this Index, p 226.

CORRECTION.

At the 124th page it is ſaid that the mountain range of gneiſs, mica-ſlate and talcoſe rock including Saddle Mountain, is inſulated or peninſular, on account of the meeting of the two ranges of granular limeſtone. Since that part of the Index was ſtruck off, the 2d Vice Preſident of the Lyceum, David Buel, Jun. Eſq. has attentively traced the weſtern range of lime rock, and finds it interrupted for a narrow ſpace by a branch of the talco-micaceous rock, which croſſes the valley near the ſoutheaſt corner of Weſt-Stockbridge. This branch directs its courſe towards the Taghconnuc mountain, and may be the connecting link between the Highland and Hinſdale primitive ranges.

Explanation of the Plates.

IN addition to explanations of PLATE I. in the forepart of the book, it should be observed that Fig. 3, is to represent a secondary country, where both transition and secondary rocks appear. By attending to the numbers of the interrupted fields and patches of different strata, a pretty correct view of the secondary country to the west may be formed. The figures represent the strata as follows: 1. Granite, 2. Gneiss, 3. Hornblende rock, 4. Mica-slate, 5. Talcose rock, 6. Granular limestone, 7. Argillite, 8. Metalliferous limestone, 9. Graywacke, 10. Red sandstone, 11. Breccia, 12. Compact limestone, 13. Gypsum, 14. Secondary sandstone, 15. Basalt, 16. Greenstone trap.

PLATE II. is intended to represent the probable appearance of the rocks between Susquehanna river near Jericho in the state of New-York, and the Atlantic ocean at Boston in Massachusetts. The rocks on the surface are laid down from actual observation; and, from an attentive consideration of the facts recorded in this Index, it is inferred, that should these rocks be cut across several miles in depth, they might present appearances in some measure resembling these drawings. The height of the mountains, &c. is greatly disproportioned to the real extent of the section. In such a section the deformities of the country must be highly carricatured, in order to represent them to advantage on a plate.

The lower section on the plate is but a continuation of the upper one. The figures represent similar strata *with those* set down for Fig. 3, Plate I.

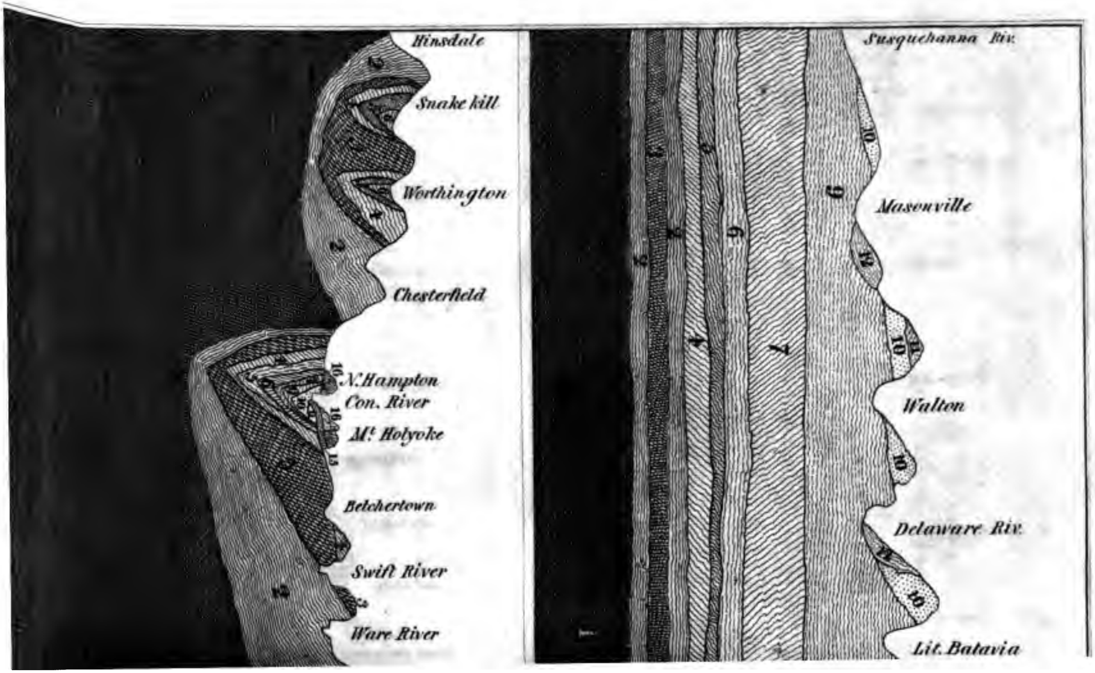
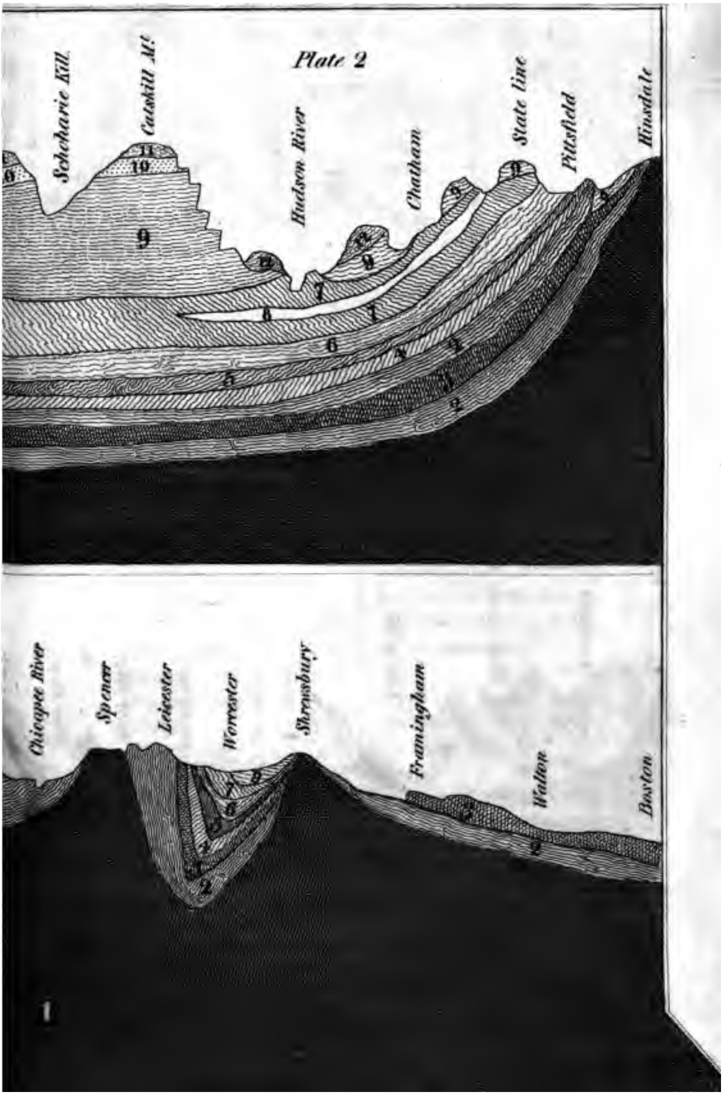

Hinsdale
Snake kill
Worthington
Chesterfield
N. Hampton
Con. River
Mt Holyoke
Belchertown
Swift River
Ware River
Susquehanna Riv.
Masonville
Walton
Delaware Riv.
Lit. Batavia
1
2
3
4
5
6
7
9
10
11
12
15
16

Plate 2


Schoharie Kill.
Catskill Mt.
Hudson River
Chatham
State line
Pittsfield
Hinsdale
Chicopee River
Spencer
Leicester
Worcester
Shrewsbury
Framingham
Walton
Boston
1
2
3
4
5
6
7
8
9
10
11
12

INDEX AND VOCABULARY.

A

ACTYNOLITE 138

Adularia 94

Aggregated, united by adhesion.

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Agate breccia 221

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Alluvion 49, 262

Alphabet 19

Alum-slate 175

Amethystine quartz, it is violet blue 251

Amphibiolite 70

Amygdaloid 46, 134, 249

Amorphous, without any regular shape, uncrystallized.

Analcime 251

Analysis of soils 60

Anhydrous, not containing any water.

Anomalous 166, 179

Anthracite, hard shining coal which burns without smoke 163

Antimony 212

Argillaceous, clayey.

Argillite 21, 36, 163

Arsenic 118, 138

Asbestos 161

Augite 105, 161

B

Barytes 101, 111, 131, 165.

Basalt 46, 134, 249

Basanite 177

Bed, an extensive mass interposed between strata or layers 165

Beryl 93, 104, 118, 121

Bismuth 104, 105

Bitumen, a mineral substance in appearance resembling pitch. It gives the peculiar odour to burning pit coal.

Bituminous shale 234

Blende 111

Blocks, fragments of rocks, in size between pebbles and boulders, perhaps between six, and twenty-four, inches in diameter.

Bones 218, 219, 266

Boulders, large fragments of rocks; larger than blocks.

Breccia 42, 194, 217

Breccioids, resembling breccia in appearance but not in geological relations 221

Brittle slate 191, 209

Buel's observations 126

C

Calcareous sandstone 35

Calcareous spar, crystallized, or semi-crys-

tallized carbonate of lime 251
Capillary, shaped like a hair.
Carbon, the basis of charcoal.
Carbonate, any compound consisting of a base chemically combined with carbonic acid.
Carbonate of iron 104
Carbonic acid, the basis of charcoal chemically combined with oxygen.
Carburet of iron 173, 202
Catskill Mt. 193
Caverns 230, 232, 239
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Chalcedony 104, 239, 251
Chalk 233
Chalybeate springs 117, 204
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Cleavage, a natural fissure or place of separation in a mineral.
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Concentric, when spherical layers lie over each other like the coats of an onion, all having a common centre.
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Conservatives 67
Copper 101, 185, 212
Copperas water 117, 131
Corallinite 199
Corals 85
Creation, history of 273
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D
Dalaby's observations 126
Decomposition, the separation of the constituents of bodies by chemical means.
Deliquesce, to dissolve by the moisture of the atmosphere.
Dendritic, tree-shaped.
Diamond rock 177
Disintegrating agents 257
Disintegration, the crumbling down of rocks into alluvial soil.
Disseminated, when small minerals are scattered or interspersed in the substance of larger ones, or in rocks.
Dolomite 35, 161
Drawing-slate 174
E
Efflorescence, the powder on some saline or alkaline substances by

exposure to the atmosphere.
Elastic marble 161
Entomolite 71
Epidote 138
Erismatolite 85
F
Fascicular, composed of several needle-form diverging crystals.
Felspar 20, 93, 103
Fish, impressions of 163, 215
Fibrous quartz 174
Filiform, in the form of threads.
Fissile, easily split into parts.
Flint 229
Flinty slate 209
Floetz, a German word used to denote flat or nearly horizontal strata.
Floetz limestone 43
Fluor spar, fluoric acid combined with lime, 101, 111
Freestone 209
G
Garnets 144, 145
Geest [pronounced jé-est, derived from *ge*, land, and *esti*, is] 48, 257
Geognosy, nearly the same as geology. Though some geologists apply it more particularly to the theory of the formations.
Giant's causeway 250
Gibraltar 215
Glance, a German word for shining.
Glass sand 146
Glossed argillite 173
Gneiss 32, 112
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Hard water 269
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Hematitic ore 150
Hepatic water 175, 204
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Hornblende 21, 118, 140
Hornblende rock 32, 133
Hornstone 229
Hydrogen gas, inflammable air, the basis of water.
I
Ichthyolite 71
Indicolite 121
Iridescent, coloured like the rainbow.
Iron 104, 118, 132, 145, 149, 161, 265

J

Jasper 174, 234, 239

K

Kalmia 211

L

Lamellar, consisting of plates.
Lamellar quartz 251
Laminae, thin plates or leaves.
Lava 23
Lead 100, 101, 111, 185, 202, 228
Lenticular, shaped like a double convex lens, or a spectacle glass. When the resemblance is but very distant, it is still called lenticular.
Lenticular iron ore 265
Lias stratum 222
Limestone 22, 35, 43, 228
Lithographic stone 232, 239
Lydian stone 177

M

Magnesia 152, 161
Magnetic, attracted by iron.
Mammodolite 70
Manganese 124, 203
Marble 162, 226
Marl, a compact mass of carbonate of lime, clay and sand, 62, 367
Mechanical deposites, beds or layers which were deposited from a state of suspension in water.
Melanite 132, 145
Metalliferous, containing ores or metals
Metalliferous limestone 37, 164, 181
Metals 55, 210
Mica 20, 93, 121
Micaceous iron 149
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Molybdena 93, 94, 109
Money-diggers 109
Muriatic acid 268

N

Nagelfluh 220
Niagara 214
Nodule, protuberance or knob.
Nova-Scotia 217
Nutriment 62

O

Obsidian 28
Oceanic 230
Ochre, alluvial earth of various kinds combined with oxyd or carbonate of iron.
Opal 239
Organic relics 66
Oxygen, pure respirable air. When combined with a metal, it forms a rust or oxyd of it.

P

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Phosphate of lime* 110, [132
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Plumbago, or black lead, consists of carbon with a little iron 94, [105, 109, 113, 118, 124
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Potstone, a fine close-grained variety of talcose rock 147
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Primitive class 25, 31, 91
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Pyrites, combination of metals with sulphur particularly iron and copper 174, 201
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Q

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Quartzose, chiefly made up of quartz.

R

Rain 270
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Serpentine 37, 100, 110, [148, 150, 152, 162
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Shorl, black opaque prismatic crystals 104, [118, 145
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Silicious felspar 98, 121
Silicious slate 176
Silver 185, 202
Slate 227
Soapstone 147, 148
Specular, having polished faces.
Specular iron ore 149, 150
Statuary marble 162

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* Since this work went to preſs, Dr. John Torrey has informed me, that he and Mr. Pierce have diſcovered cryſtals of phoſphate of lime in mica-ſlate near N. York, one inch in diameter.

Staurotide 144
Steatite 147
Steilstein 14[illegible]
Stilbite 251
Storms 26[illegible]
Striated quartz 175
Strontian 201, 234
Subordinate 165
Sulphate, when any base is united with sulphuric acid.
Sulphate of iron 117, 131, [241
Sulphate of lime 240
Sulphuret, when sulphur, in its simple state uncombined with oxygen, is chemically combined with a metal or an alkali.
Sulphuret of iron 117, 204
Sulphuretted hydrogen 175, 176, 204
Superincumbent class 27, [46, 249

T

Tabular, table-like, broad in proportion to the thickness.
Talc 21, 147, 148
Talco-micaceous rock 146, [150
Talcose rock 34, 147
Talcose slate 174
Tellurium 104
Toadstone 249
Tourmaline, resembling shorl but is not black 98, 121
Transition class 26, 36, 163
Transition limestone 37, [183
Translucent, admitting the transmission of light but not so as to present distinct images.
Transparent, through which objects may be distinctly seen.
Trap 33, 47, 193
Tremolite 104, 161
Tufa, carbonate of lime which has been deposited from water in a concrete state 29
Tungsten 104

U

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